SAN ANTONIO

SIGGRAPH 2002

Animation From Motion Capture

Motion Capture Assisted Animation: Texturing and Synthesis

Kathy Pullen

Chris Bregler

Related Work: Animation With Style

M. Brand and A. Hertzmann. Proc. SIGGRAPH 2000, pp 183-192

D. Chi, M. Costa, L. Zhao and N. Badler. Proc. SIGGRAPH 2000, pp 1

M. Gleicher. 1997 Symposium on Interactive 3D Graphics, pp 139-14

J. Hodgins, W. L. Wooten, D. C. Broogan and J. F. O'Brien. Animating Human athletics. Proc. SIGGRAPH 1995, PP 229-238

K. Perlin and A. Goldberg. Proc. SIGGRAPH 1996, PP 205-216

Z. Popovic and A. Witkin. Proc. SIGGRAPH 1999, pp 159-168

A. Witkin and M. Kass. Computer Graphics, 22:159-168, 1988

Related Work: Signal Processing

A. Bruderlin and L. Williams. Proc. SIGGRAPH 1995, pp 97-104

J. S. De Bodnet. Proc. SIGGRAPH 1999, pp 21-28

D. J. Heeger and J. R. Bergen. Proc. SIGGRAPH 1995, pp 229-238

Z. Popovic and A. Witkin. Proc. SIGGRAPH 1999, pp 159-168

U. Unuma, K. Anjyo and R. Tekeuchi. Proc. SIGGRAPH 1995, pp 91-9

A. Witkin and Z. Popovic. Proc. SIGGRAPH 1995, PP 105-108

Related Work: Animation from Mocap

O. Arikan and D. A. Forsyth. Interactive motion generation from examples. Proc. SIGGRAPH 2002

L. Kovar, M. Gleicher, and F. Pighin. Motion Graphs. Proc. SIGGRAPH 2002

J. Lee, J. Chai, P. S. A. Reitsma, J. K. Hodgins, and N. S. Pollard. Interactive control of avatars animated with human motion data. Proc. SIGGRAPH 2002

Y. Li, T. Wang, and H. Shum. Motion Texture: A two-level statistical model for character motion synthesis

Goal: Motion Capture Assisted Animation

- Create a method that allows an artist low-level control of the motion
- Combine the strengths of keyframe animation with those of mocap

Goal: Motion Capture Assisted Animation

"Sketch" an animation by keyframing

Goal: Motion Capture Assisted Animation

"Sketch" an animation by keyframing

- Animate only a few degrees of freedom

Goal: Motion Capture Assisted Animation

“Sketch” an animation by keyframing

- Animate only a few degrees of freedom
- Set few keyframes

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"Enhance" the result with mocap data

Goal: Motion Capture Assisted Animation

“Sketch” an animation by keyframing

- **Animate only a few degrees of freedom**
- **Set few keyframes**

“Enhance” the result with mocap data

- ***Synthesize* missing degrees of freedom**

Goal: Motion Capture Assisted Animation

“Sketch” an animation by keyframing

- Animate only a few degrees of freedom
- Set few keyframes

“Enhance” the result with mocap data

- *Synthesize* missing degrees of freedom
- *Texture* keyframed degrees of freedom

Goal: Motion Capture Assisted Animation

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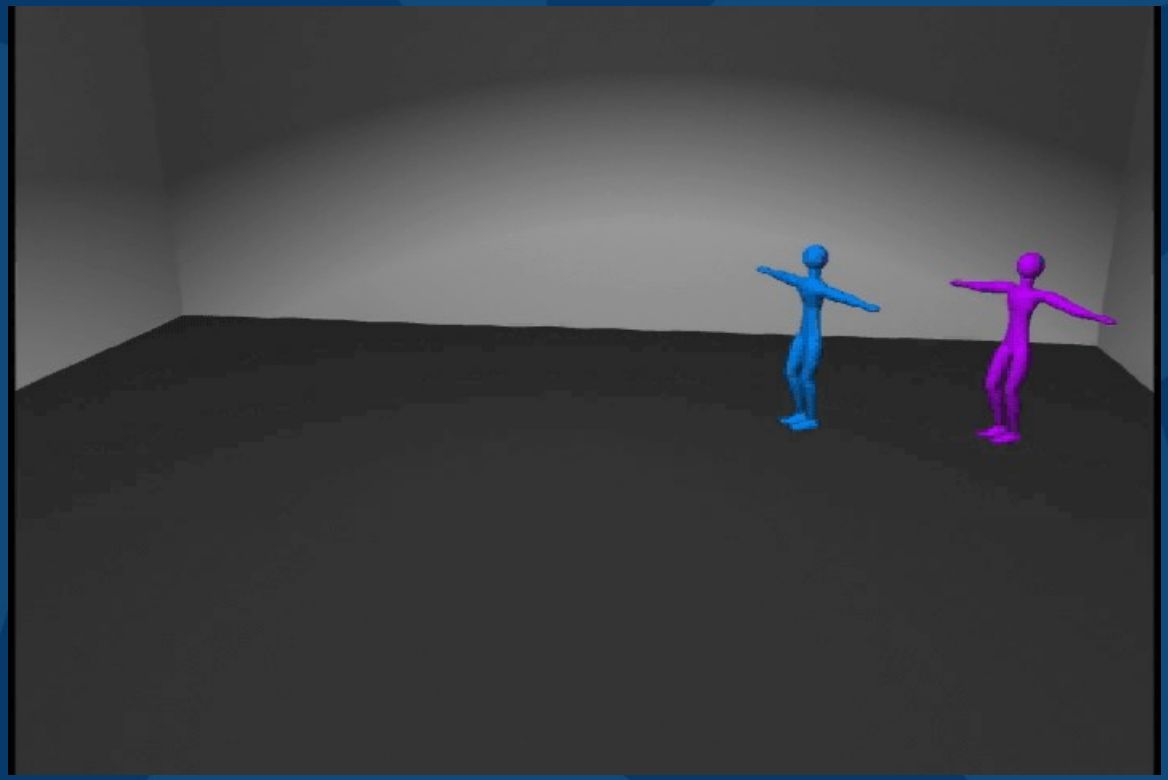
Blue = Keyframed

Purple = Textured/Synthesized



What is a Motion Texture?

Every individual's movement is unique

- **"Motion texture" was coined by Ken Perlin**

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- **Dance! Acrobatics!**

What is a Motion Texture?

Every individual's movement is unique

- **"Motion texture" was coined by Ken Perlin**
- **Dance! Acrobatics!**
- **Everyone walks, but not the same way**

Animating With Motion Texture

Every individual's movement is unique

- **Synthetic motion should capture the texture**

Animating With Motion Texture

Every individual's movement is unique

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- To "texture" means to add style to a pre-existing motion

Animating With Motion Texture

Every individual's movement is unique

- Synthetic motion should capture the texture
- To "texture" means to add style to a pre-existing motion
- Technically, texturing is a special case of synthesis

Keyframing vs. Mocap

	Advantages	Disadvantages
Keyframing	• Control	
Mocap		

Keyframing vs. Mocap

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Keyframing	• Control • Intuitive	
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Mocap	• Detail easy • All DOF	• No control • Not intuitive

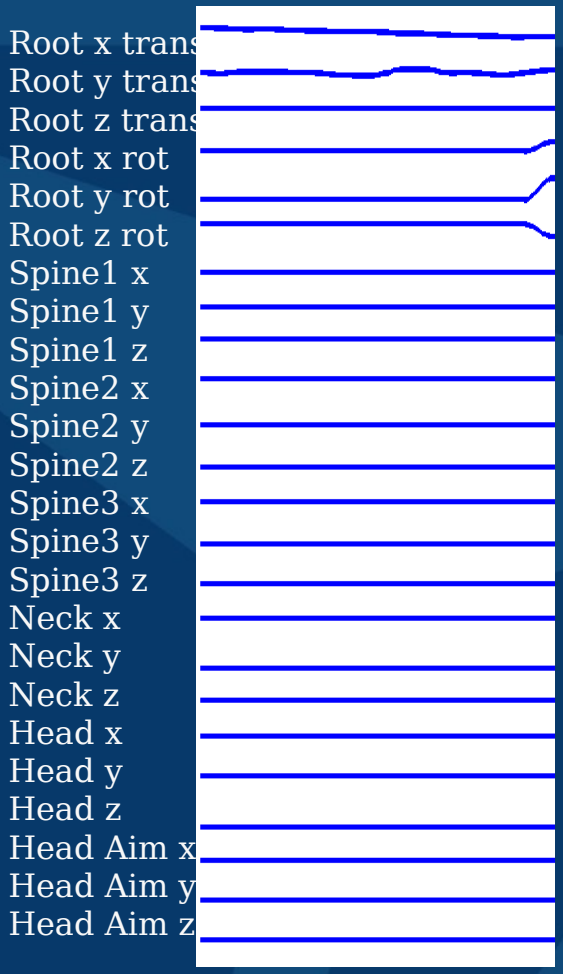
How an Animator Works

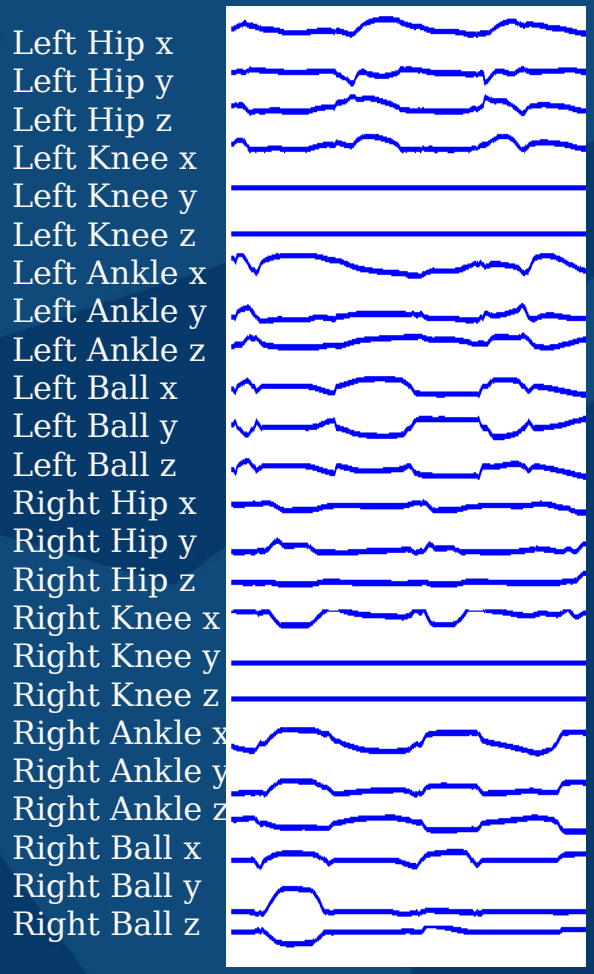
- A few degrees of freedom at first
- Not in detail
- Fill in detail with more keyframes later

The Method in Words

- Choose degrees of freedom to drive the animation
- Compare these degrees of freedom from the keyframed data to mocap
- Find similar regions
- Look at what the rest of the body is doing in those regions
- Put that data onto the keyframed animation

Before Beginning: Choose Matching Angles





Matching Angles Drive the Synthesis

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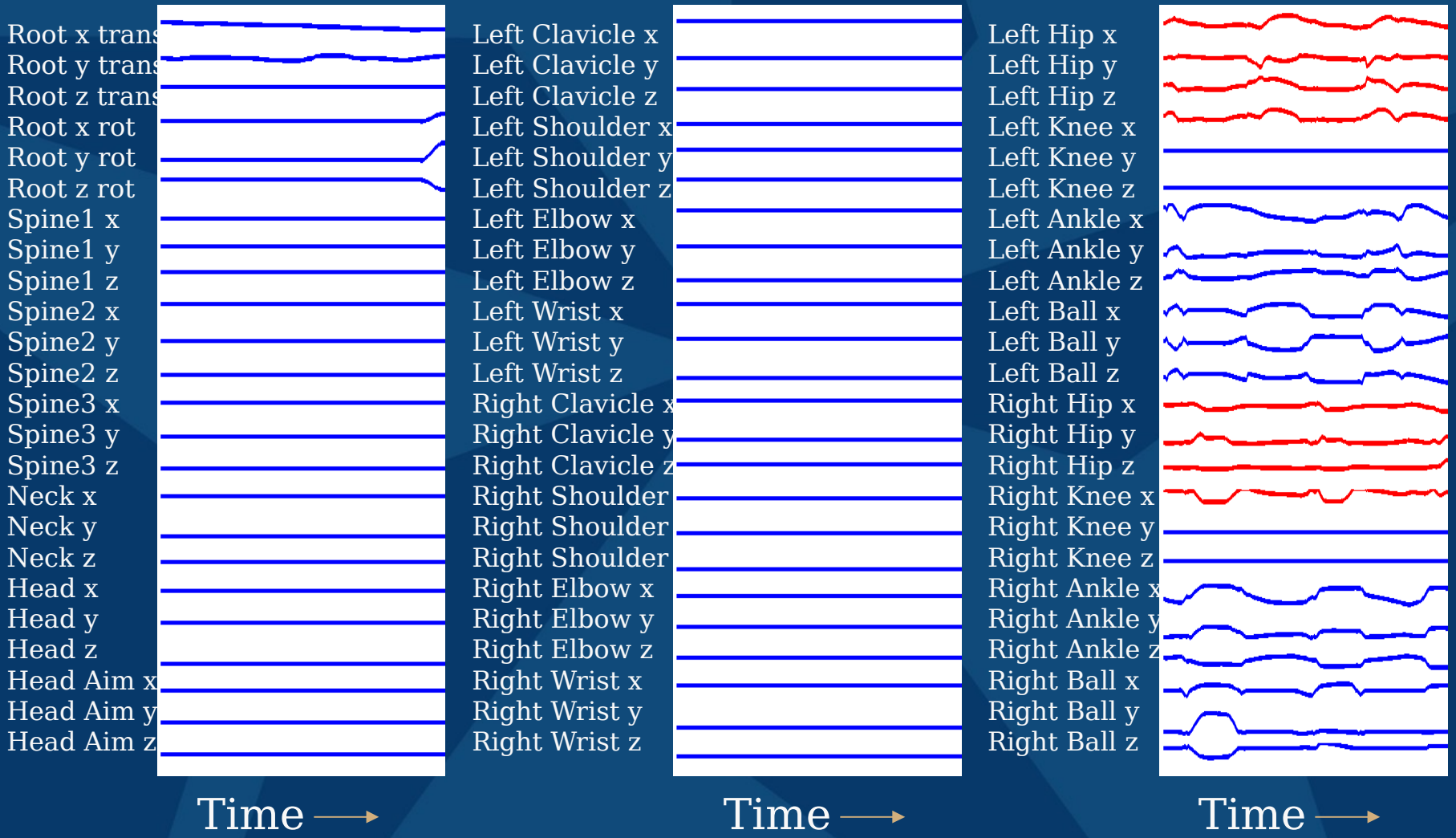

Motion Capture Data

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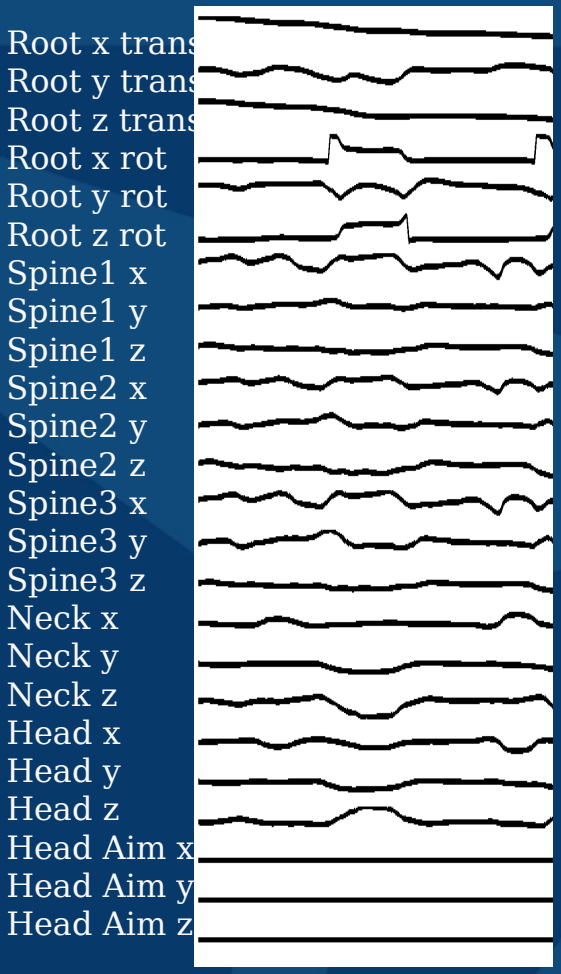

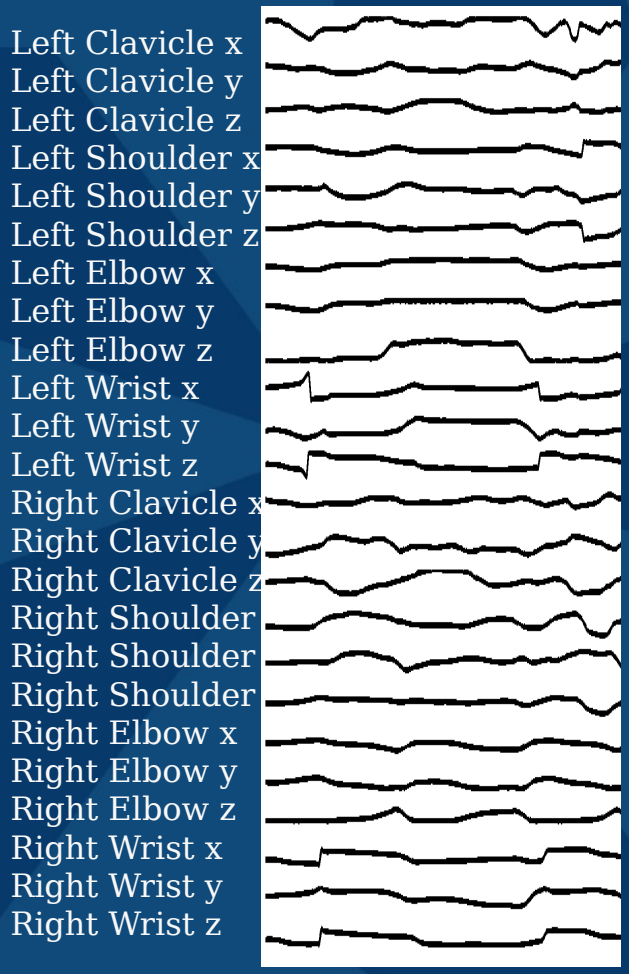

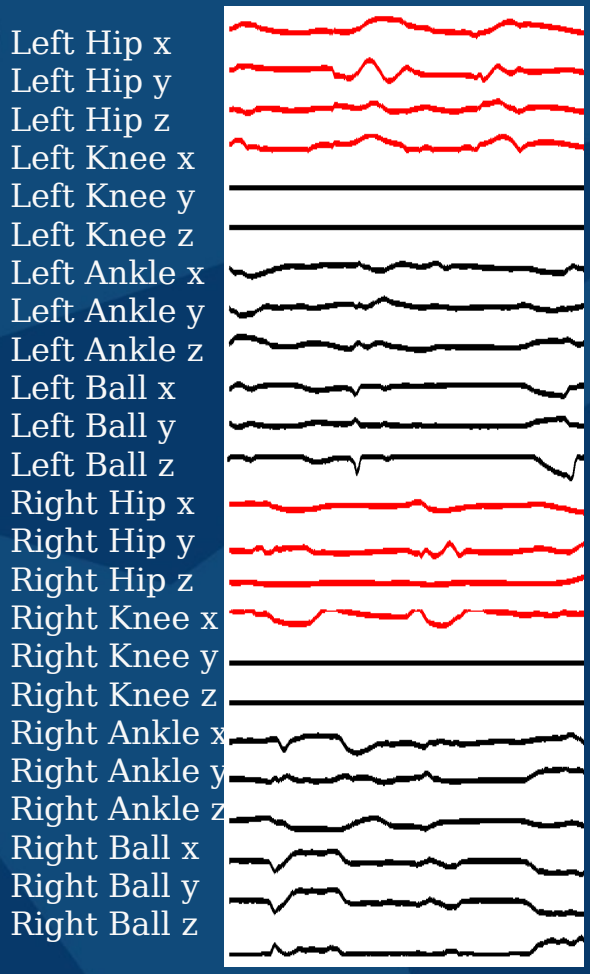

Overview

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Steps in texture/synthesis method

- Frequency analysis
- Matching
- Path finding
- Joining

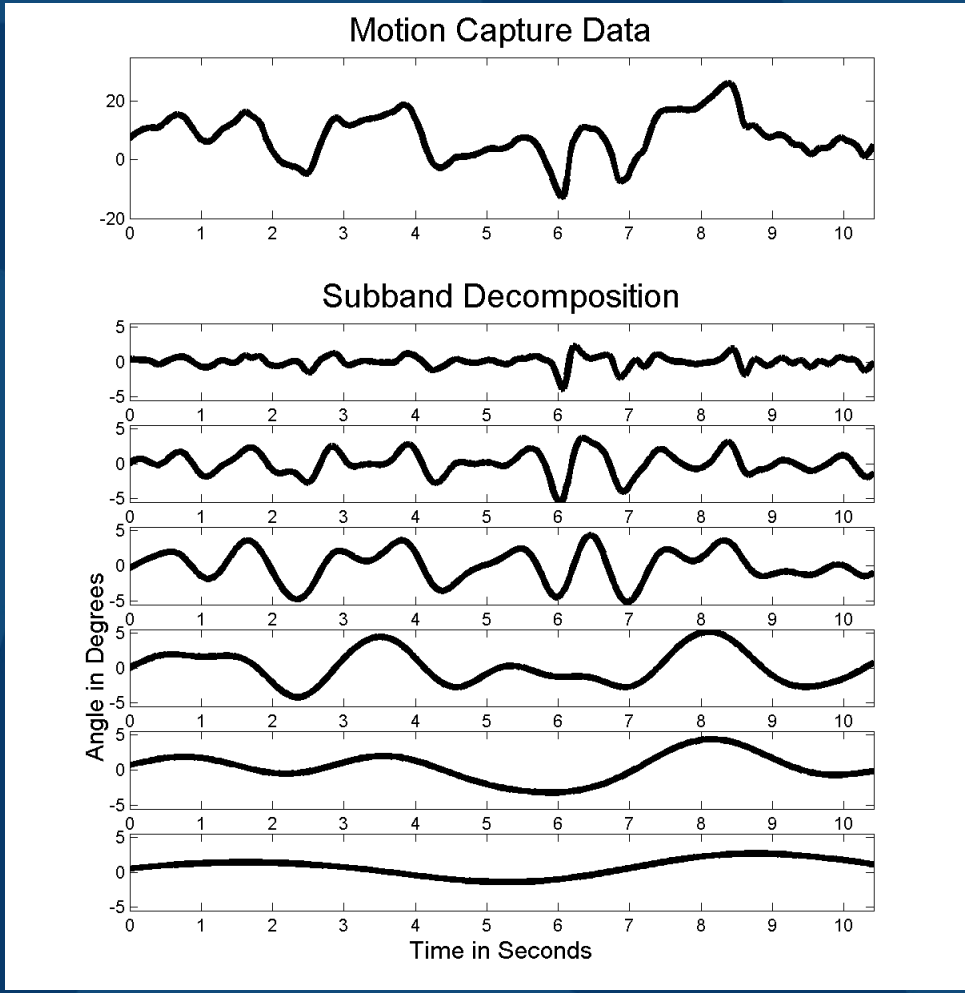
Example

In the following series of slides:

Hip angle = matching angle

Spine angle = angle being synthesized

Frequency Analysis: Break into Bands



Frequency Analysis

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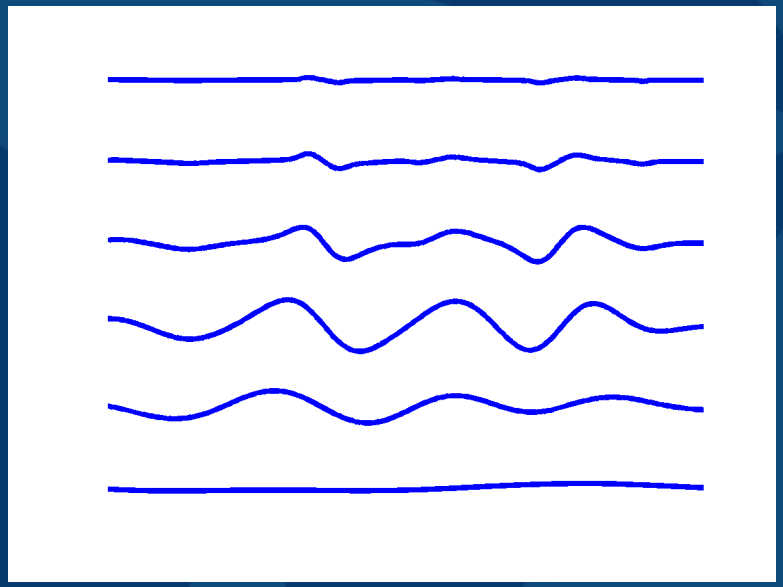
Band-pass decomposition of matching angle

Keyframed Data



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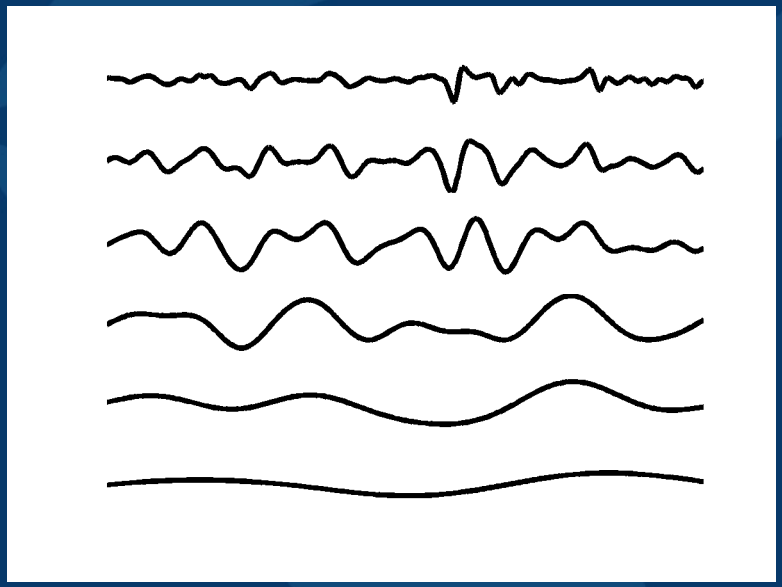

Frequency Analysis

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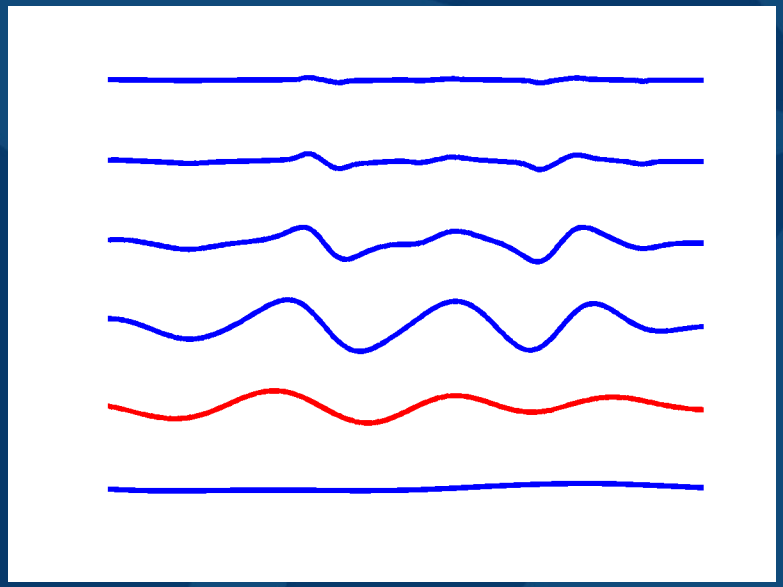
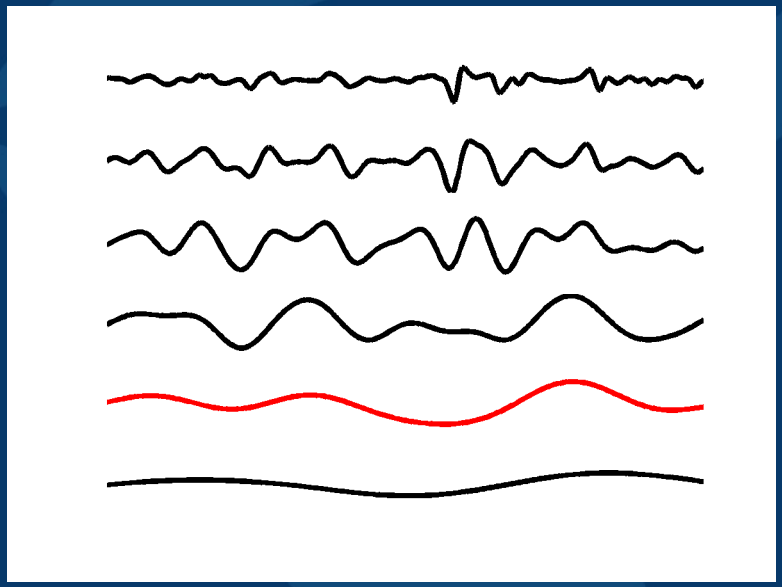
Chosen low frequency band

Keyframed Data



Motion Capture Data



Chosen Low Frequency Band

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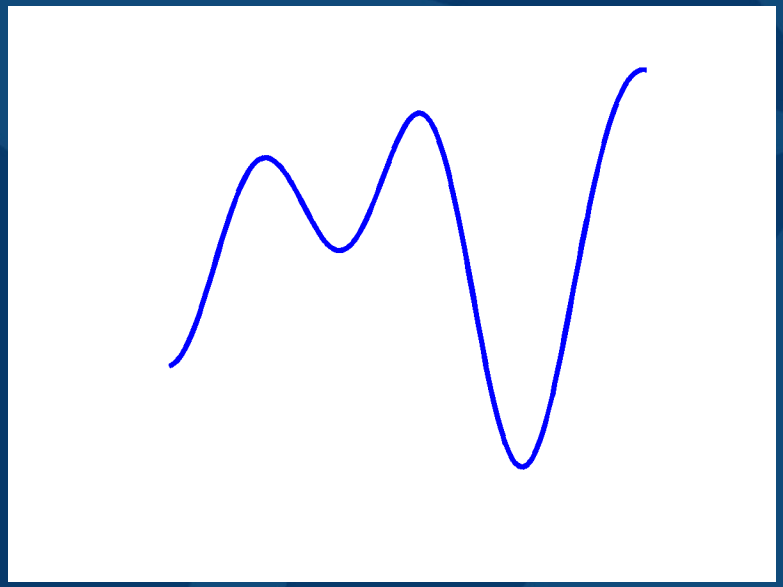
Hip angle data (a matching angle)

Keyframed Data



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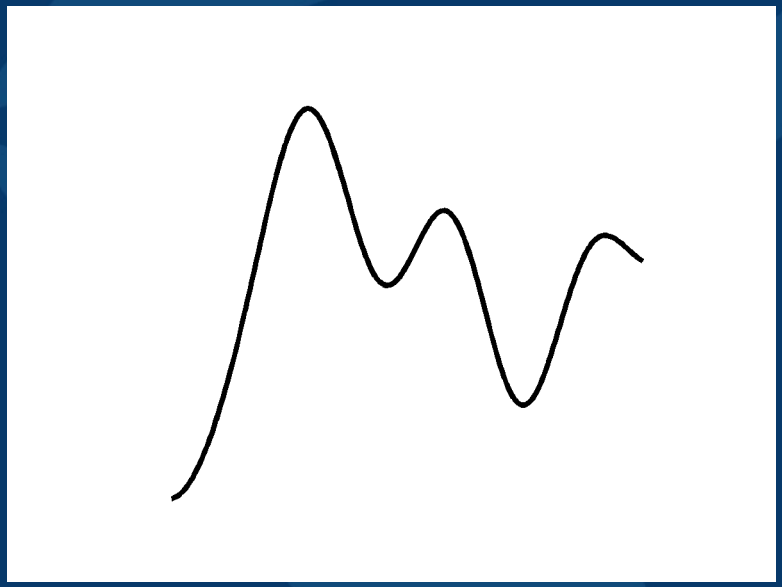

Making Fragments

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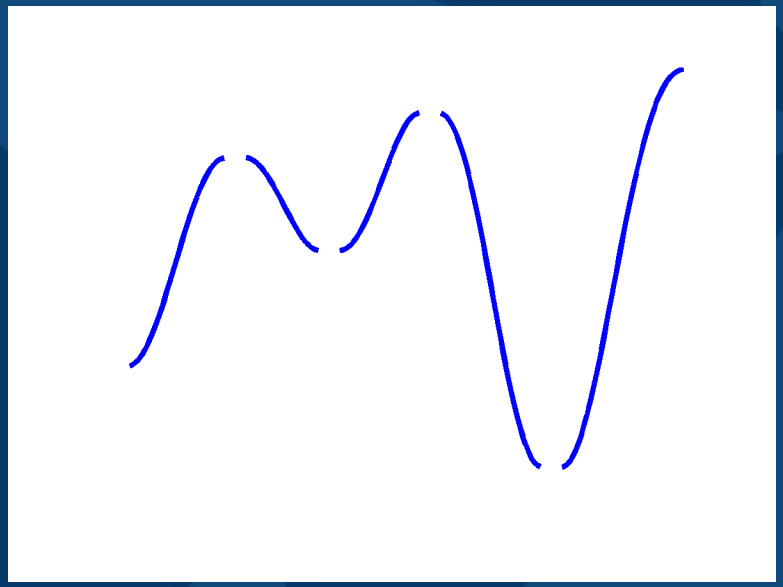
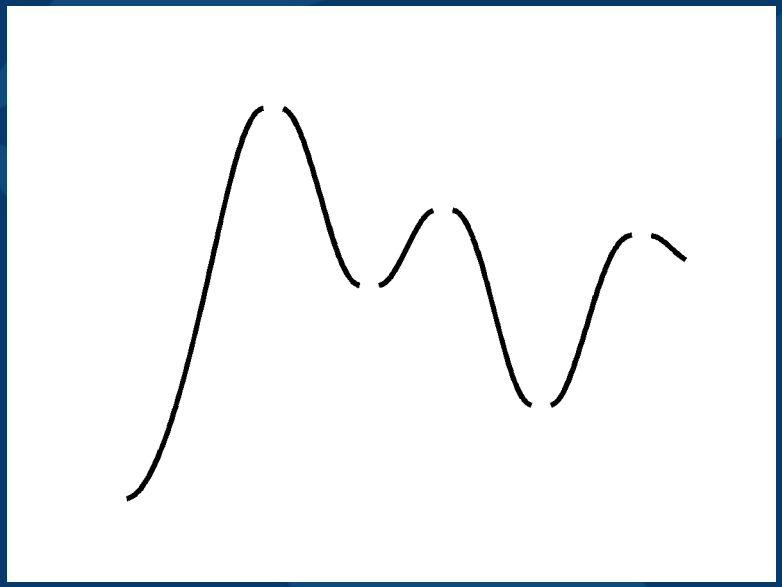
Break where first derivative changes sign

Keyframed Data



Motion Capture Data



Making Fragments

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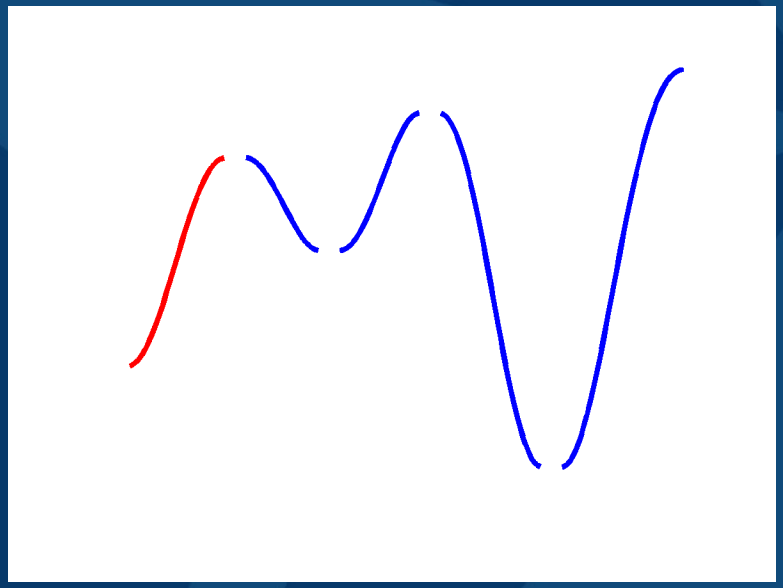
Step through fragments one by one

Keyframed Data



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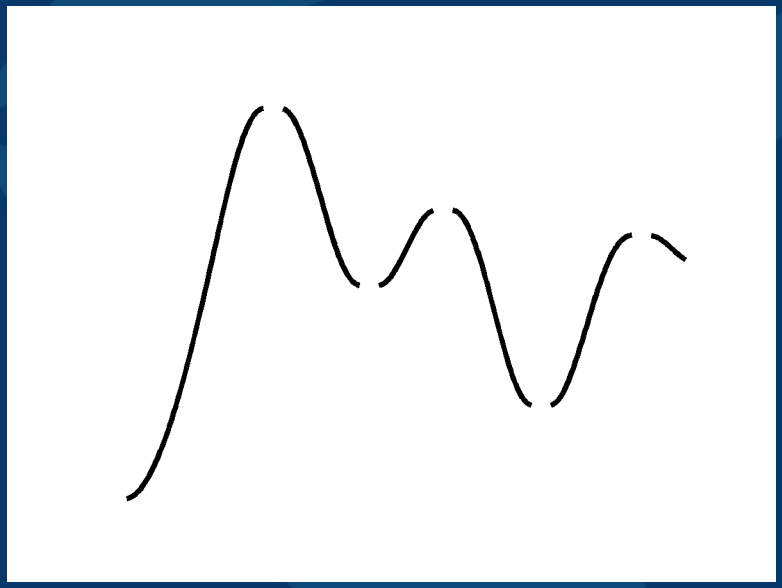
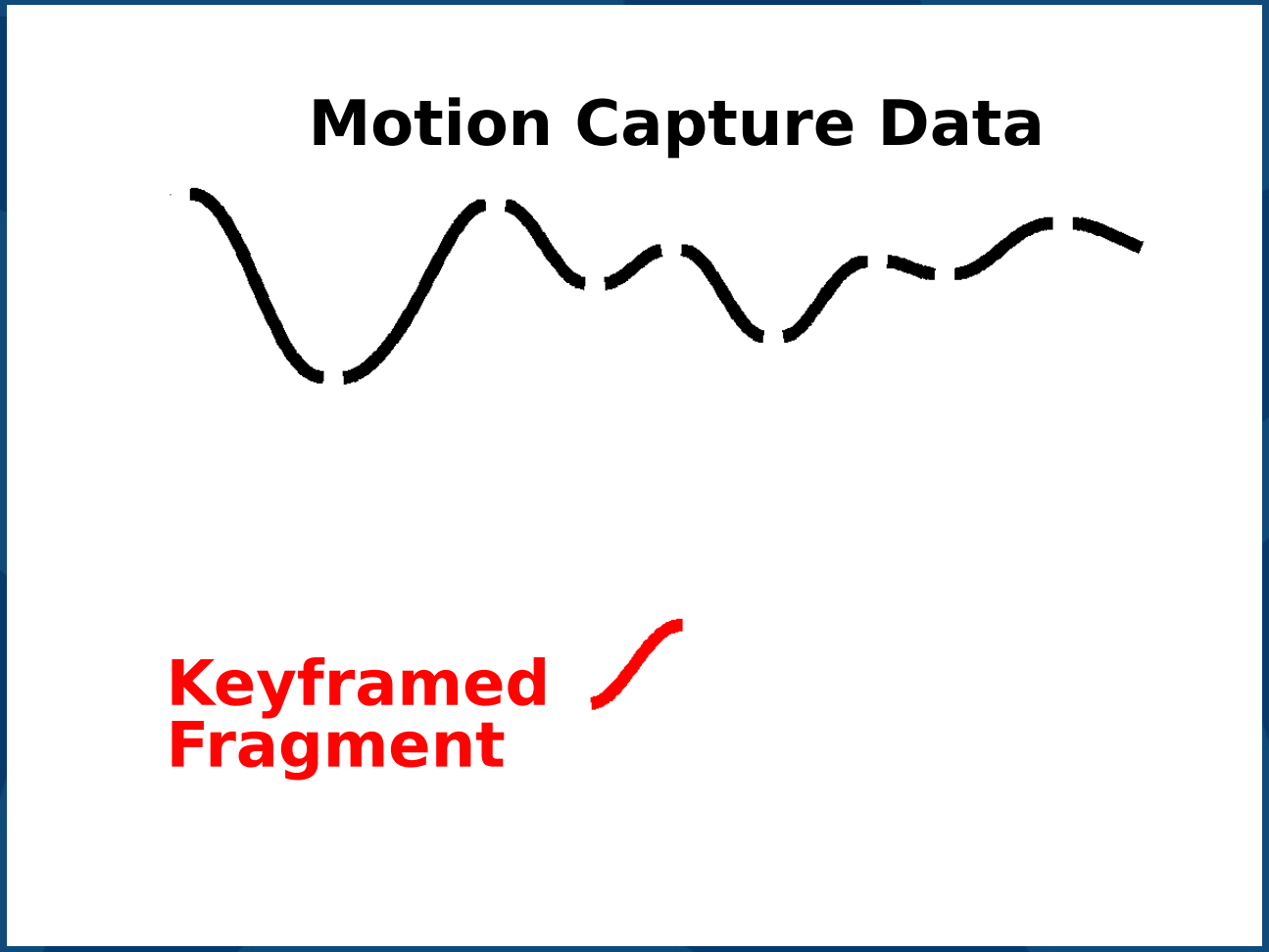


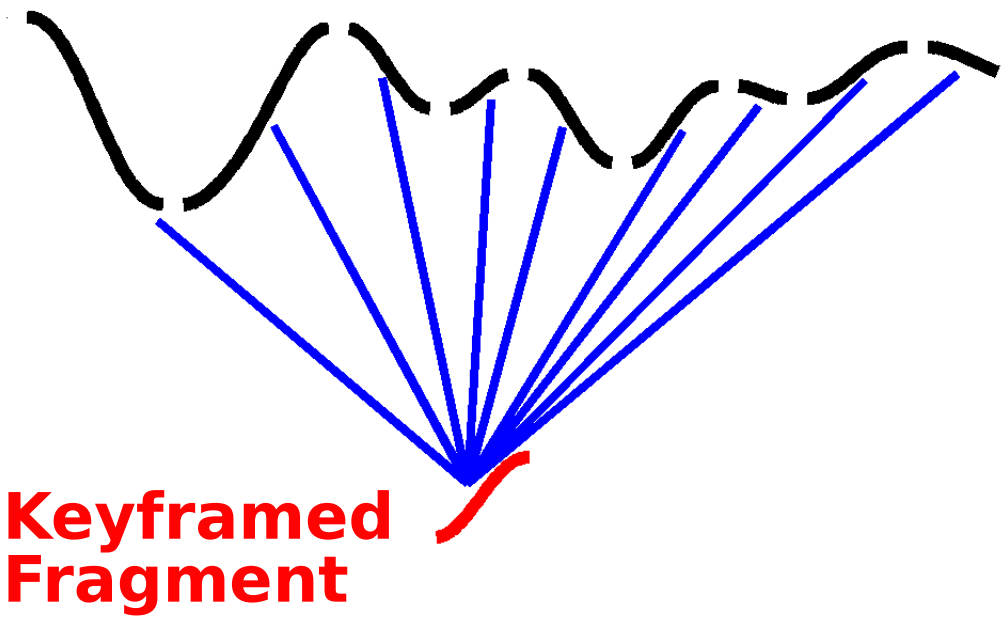
Matching

Keyframed Fragment

Matching

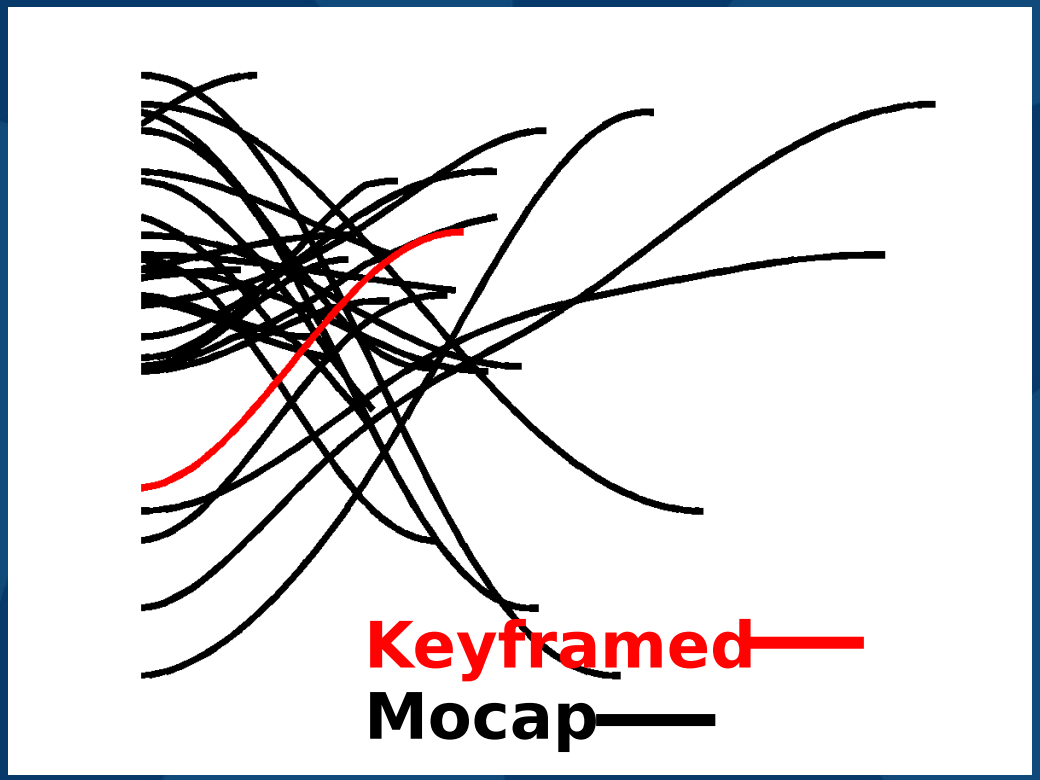


Matching



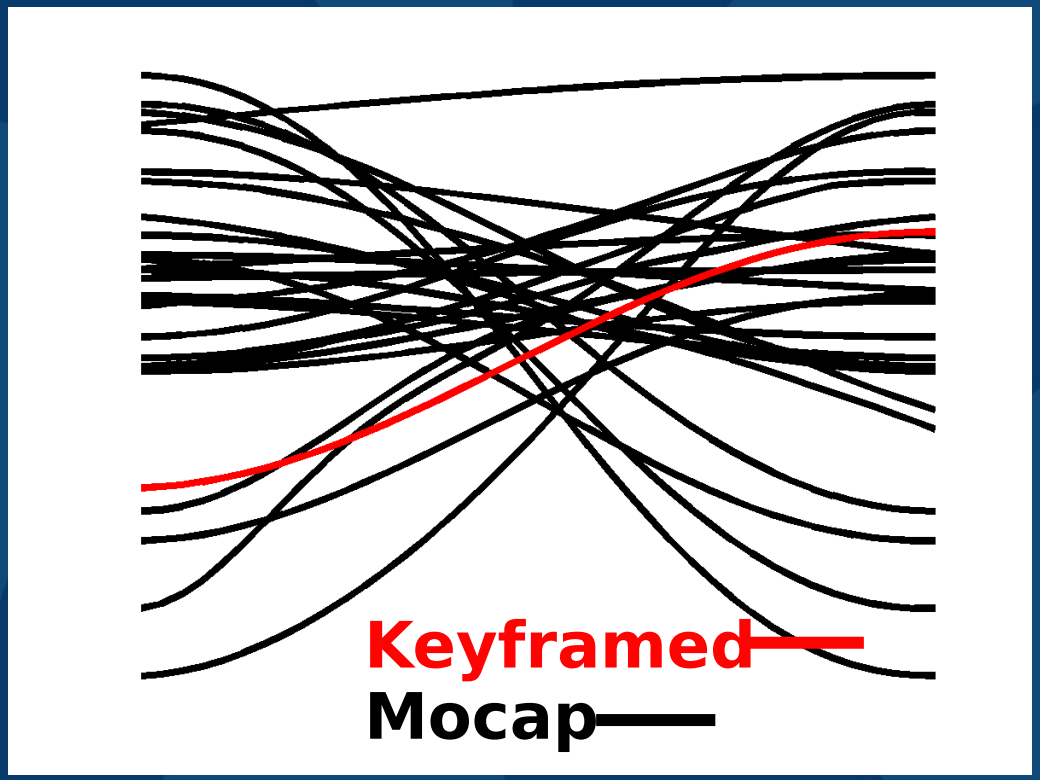
Matching

Compare to all motion capture fragments



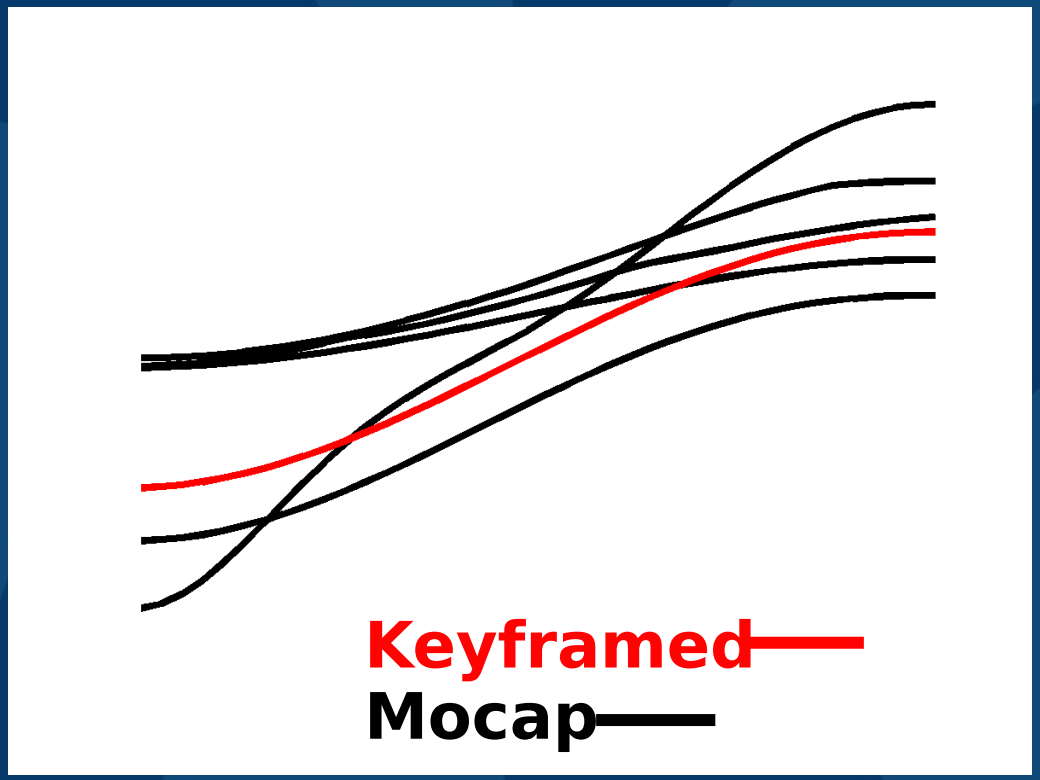
Matching

Resample mocap fragments to be same leng

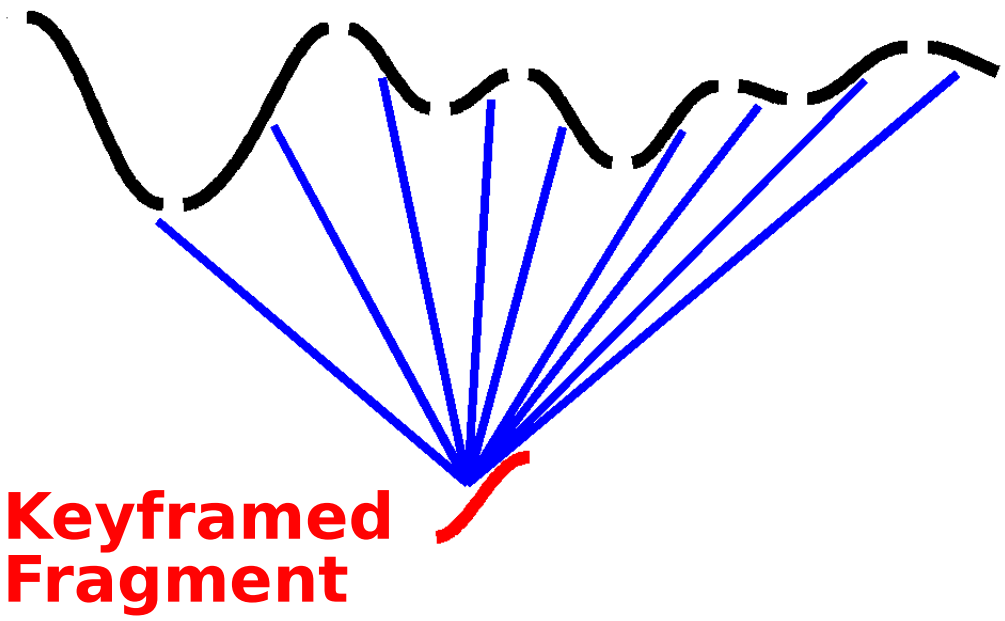


Matching

Keep the K closest matches



Matching



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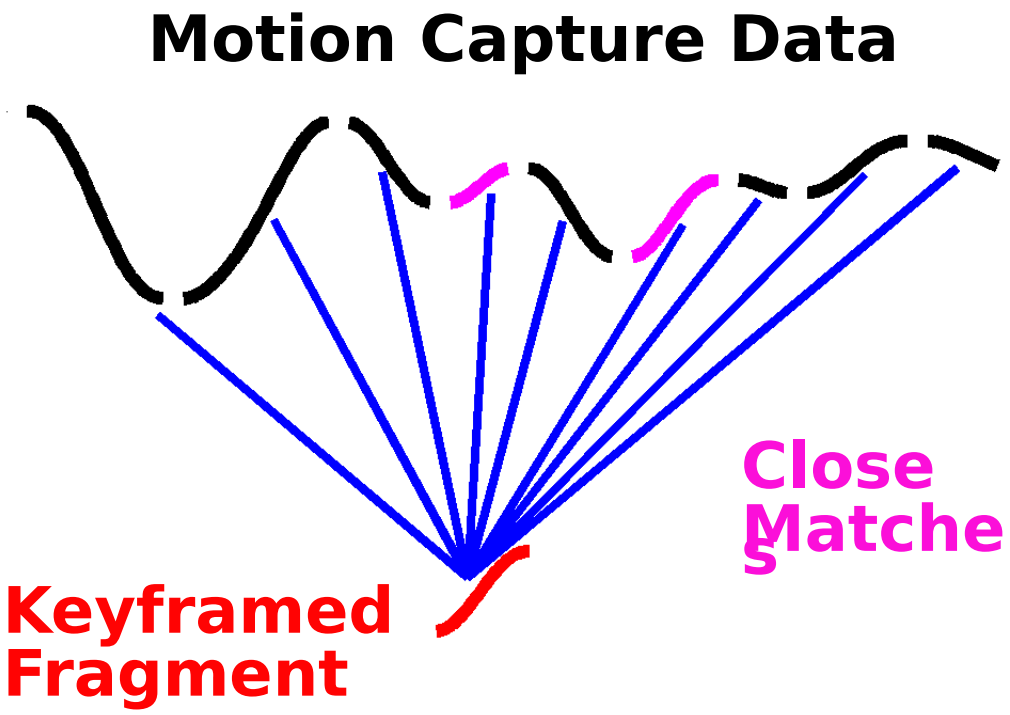

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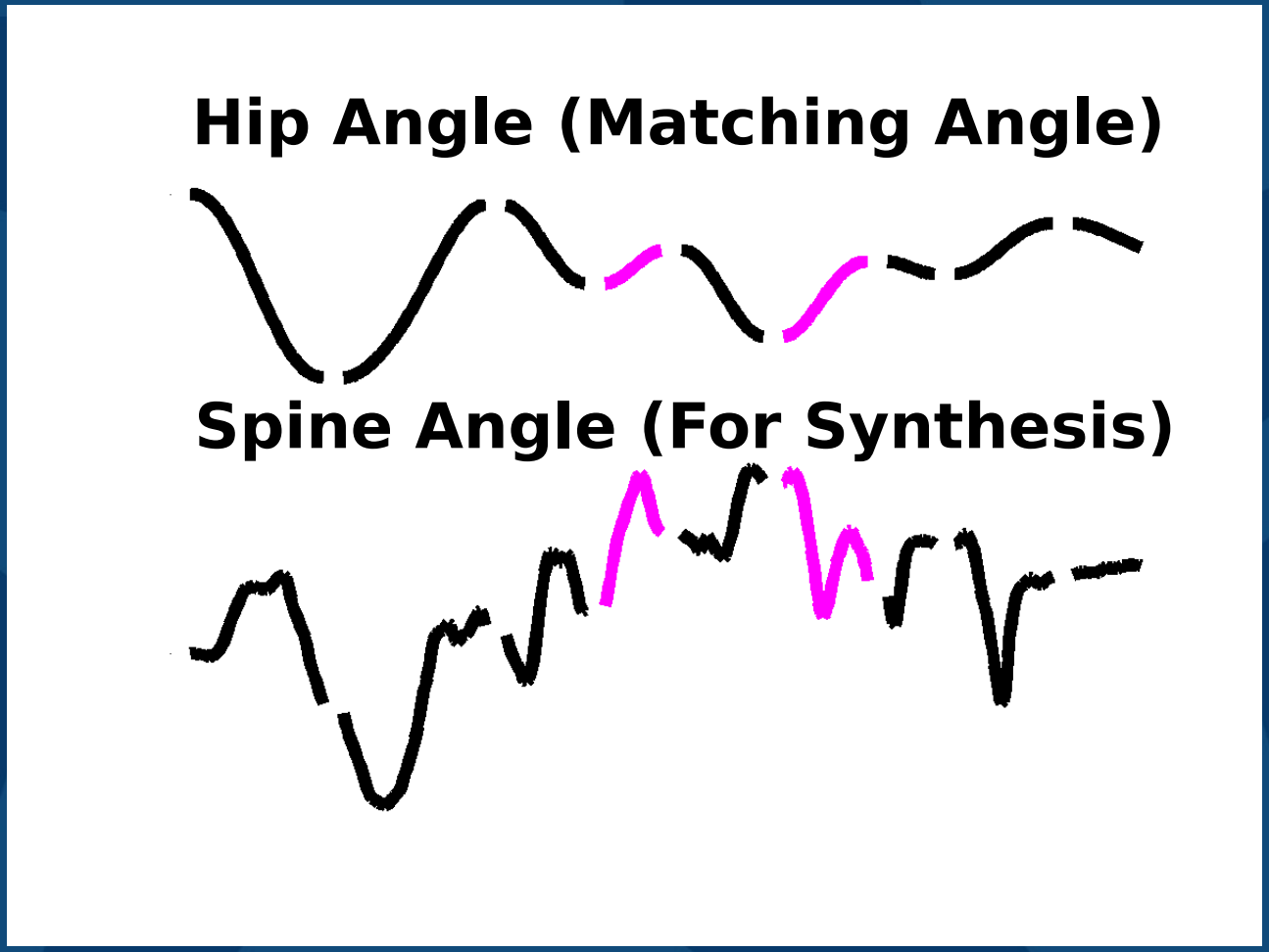

Matching and Synthesis

Low frequency hip angle data (a matching angl

Spine angle data to be synthesized

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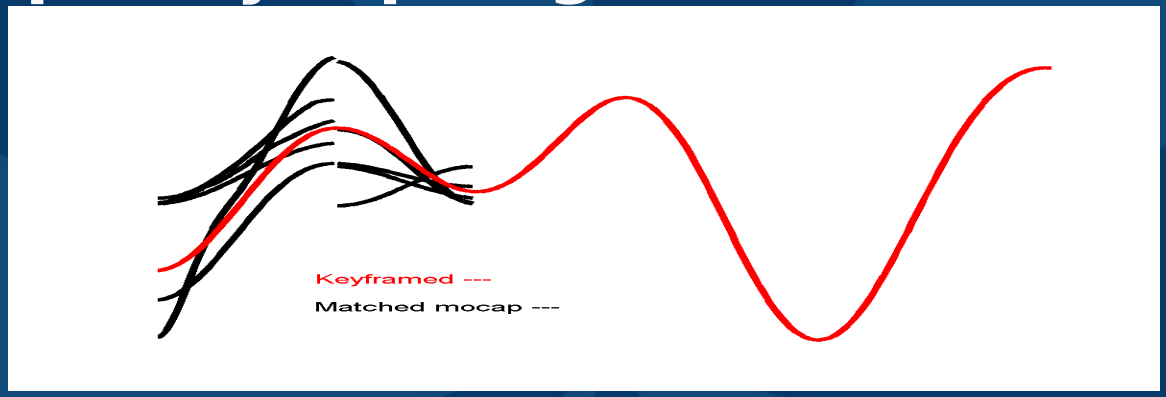

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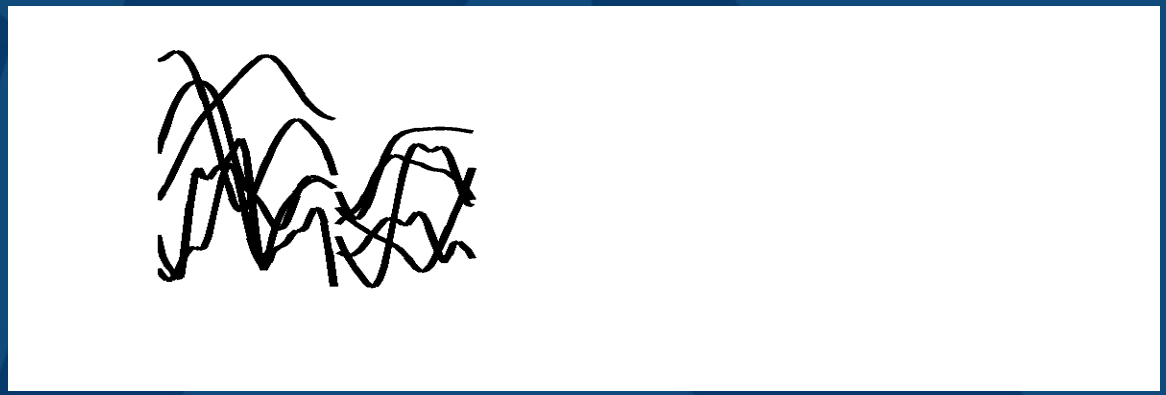

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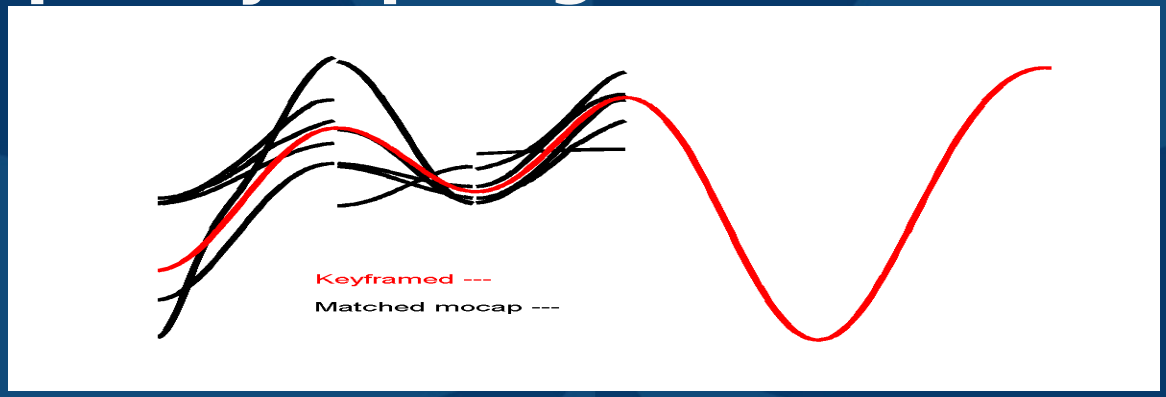

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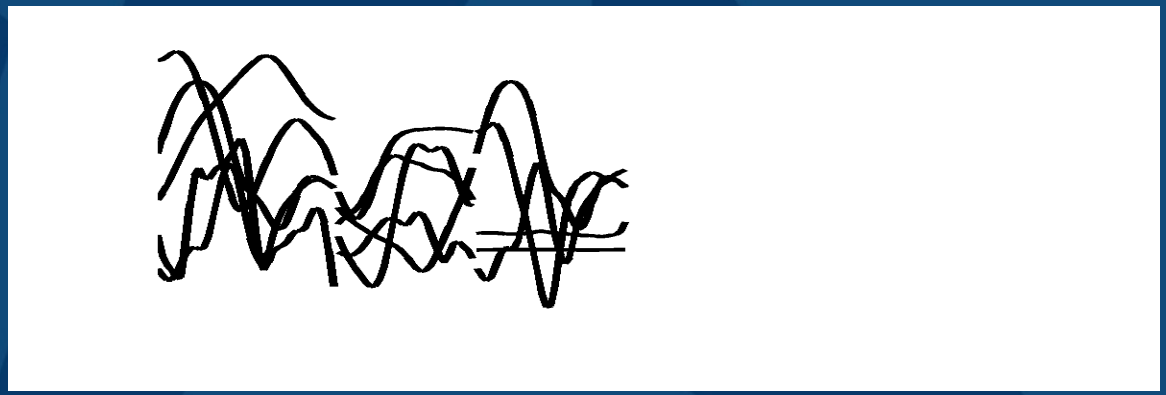

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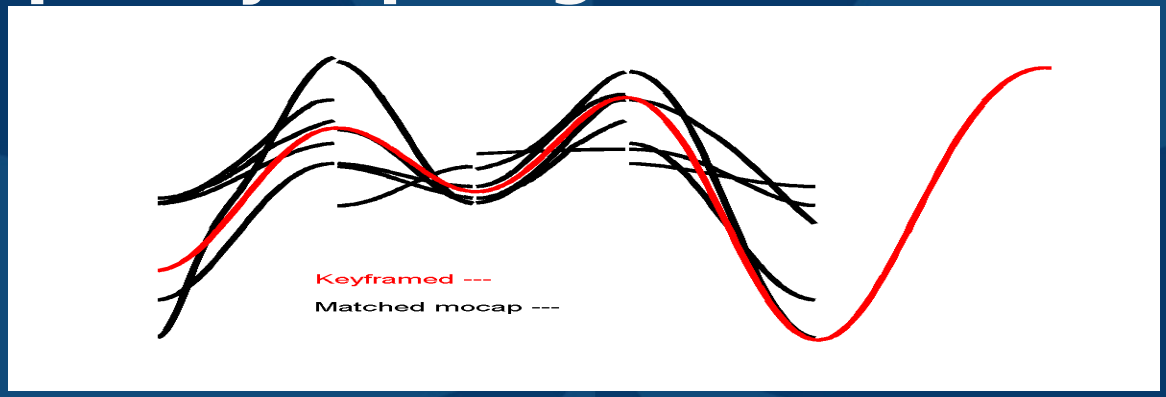

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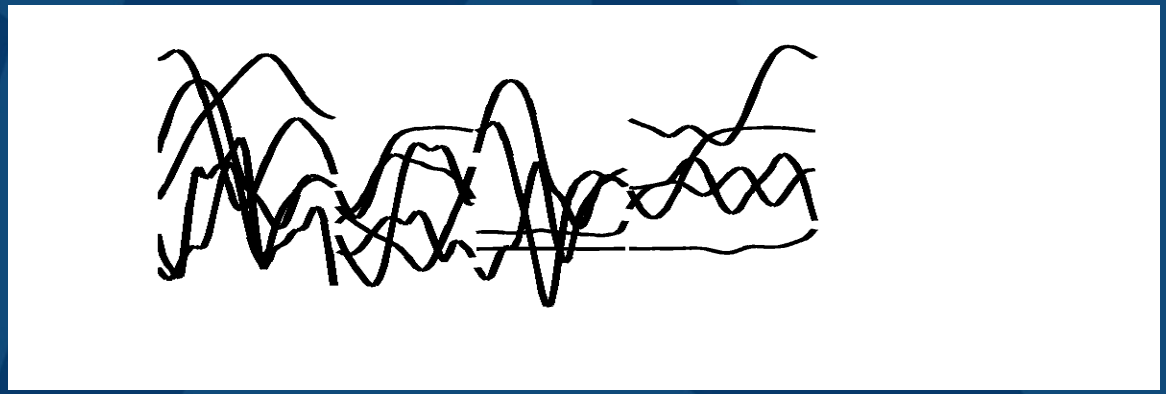

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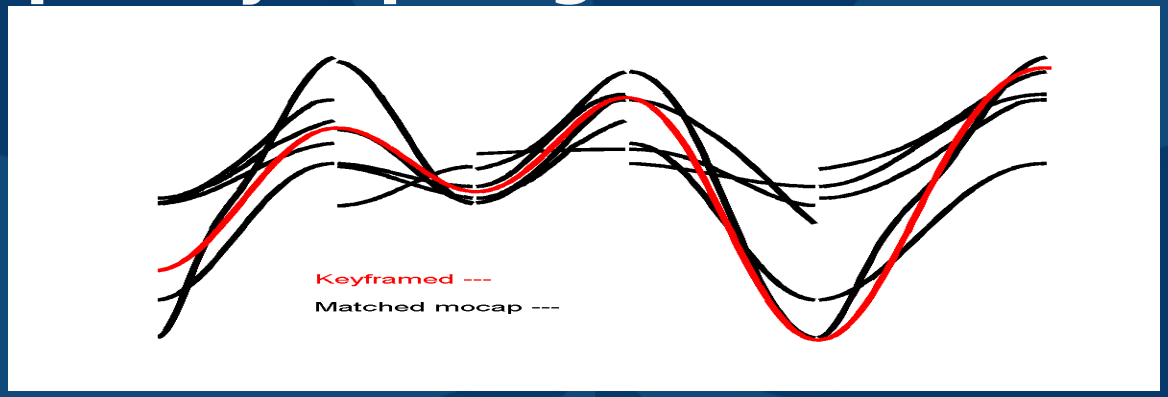

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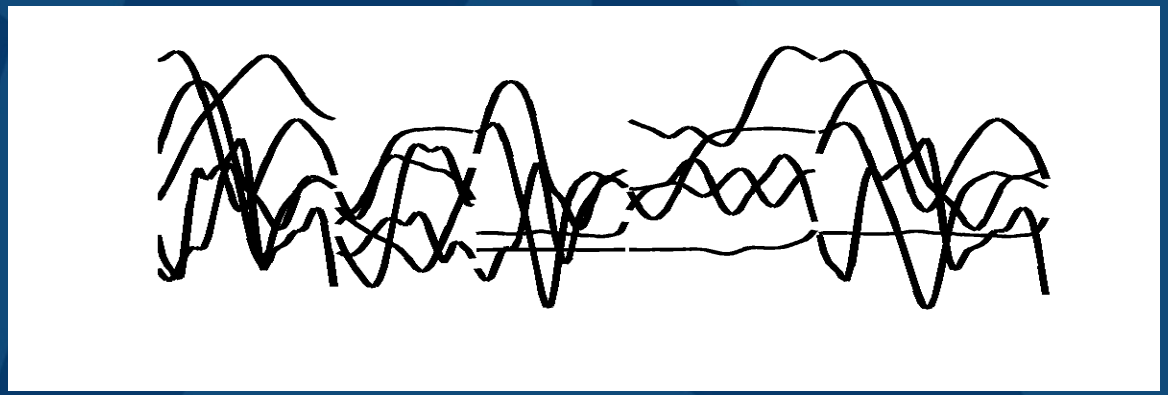
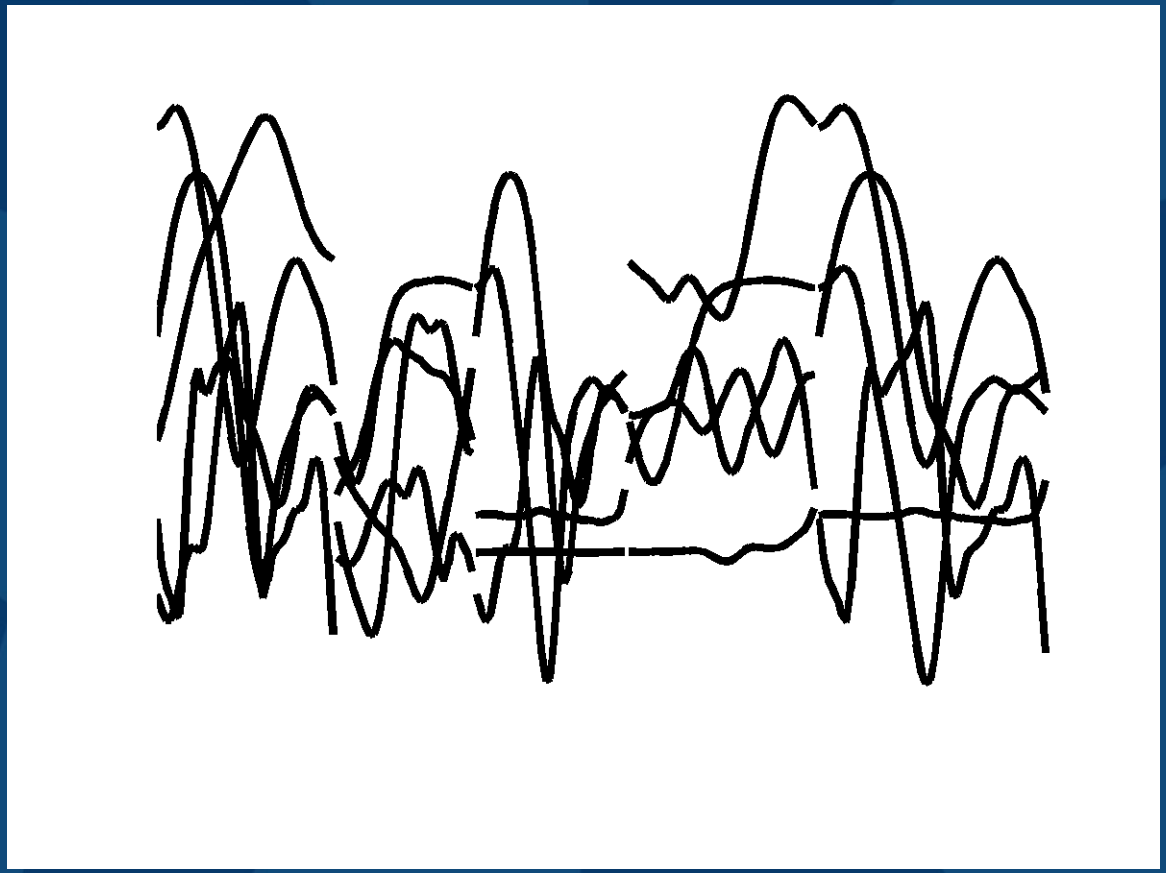
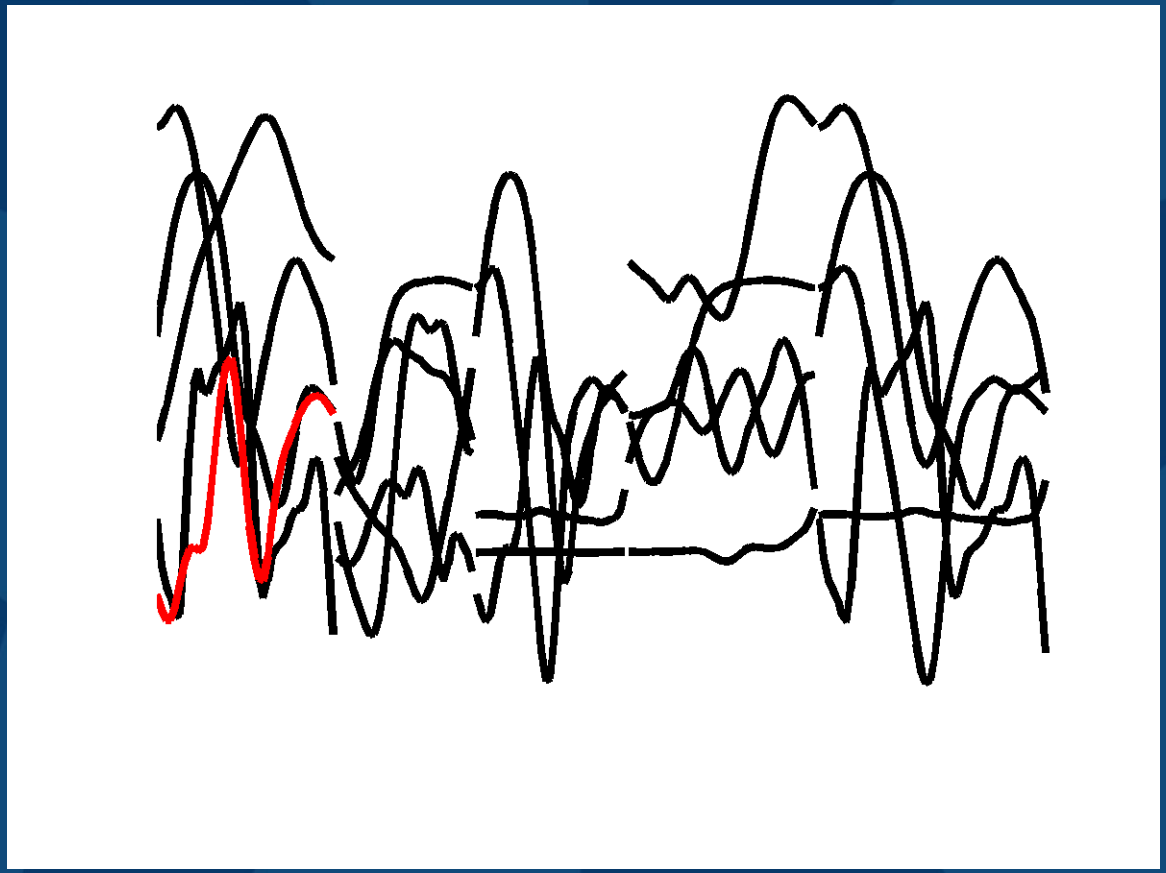


Possible Synthetic Spine Angle Data



Path Finding



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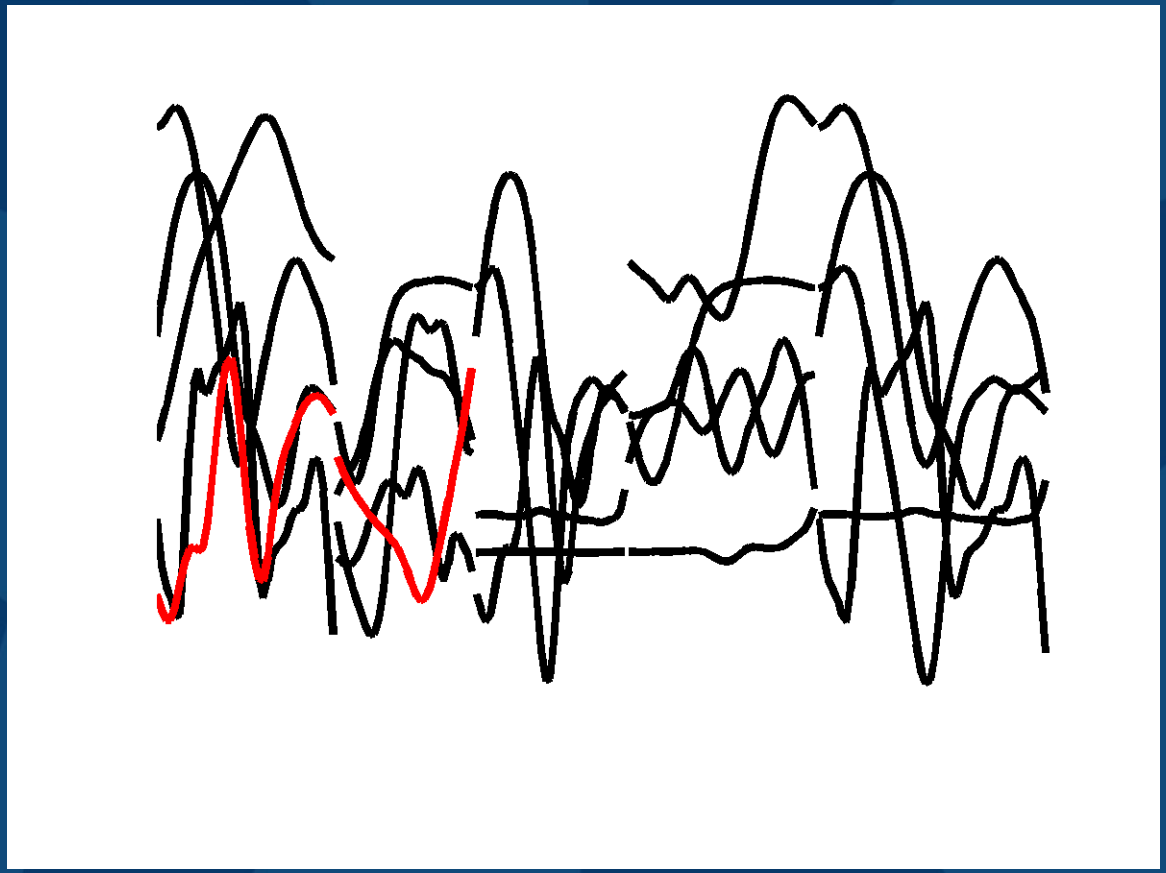

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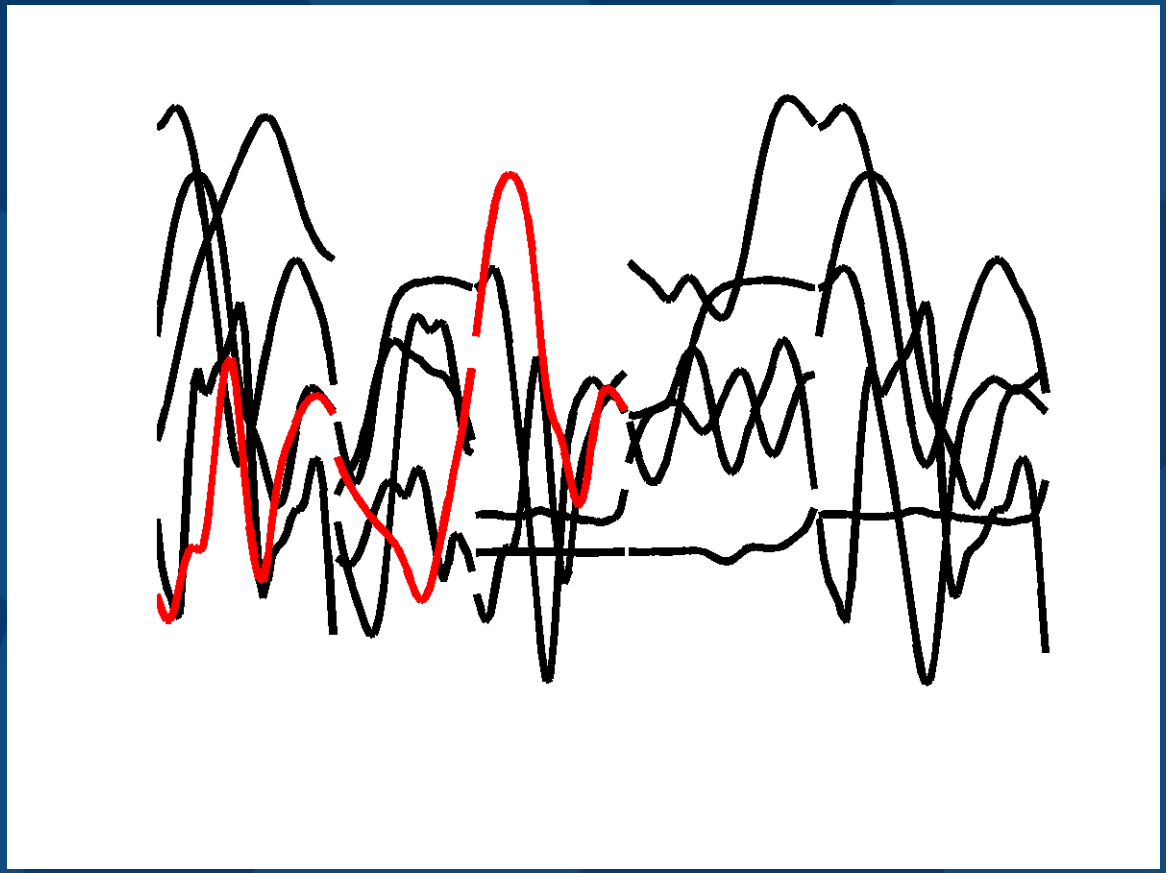

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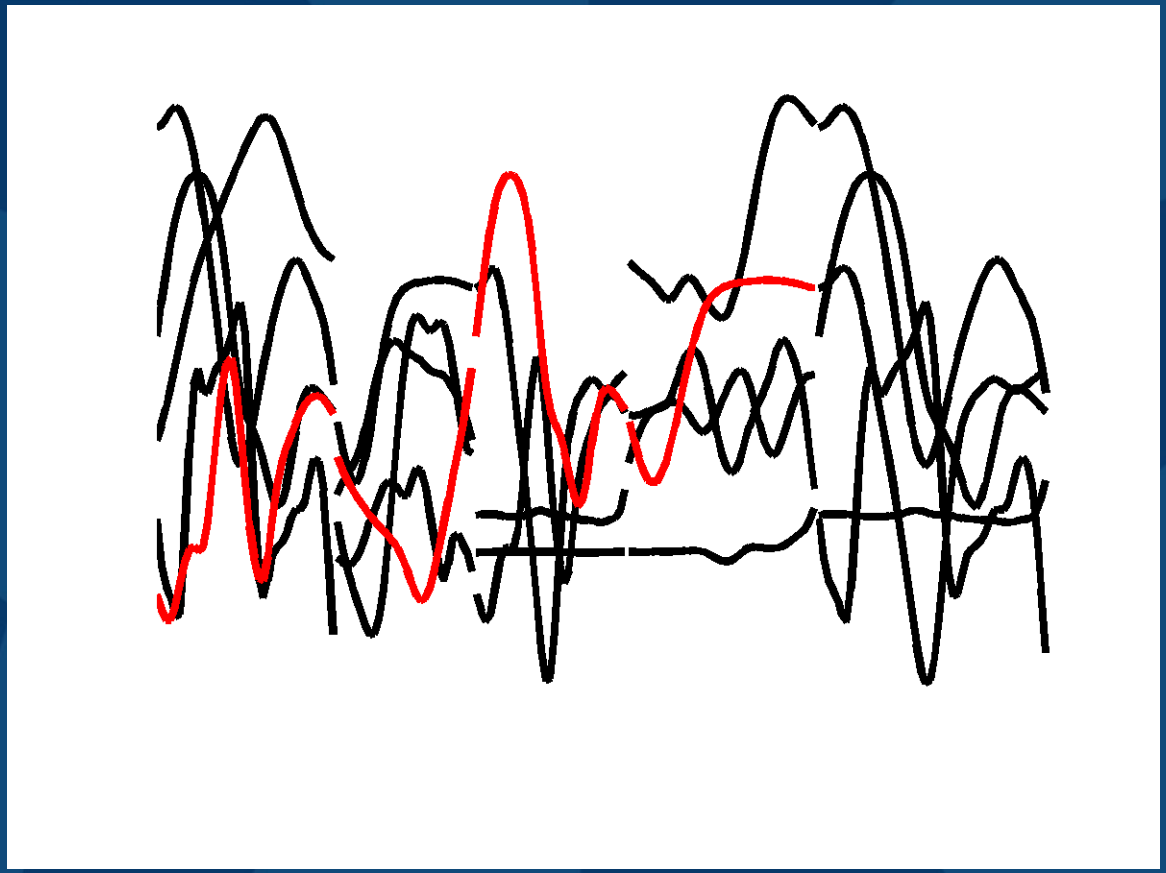

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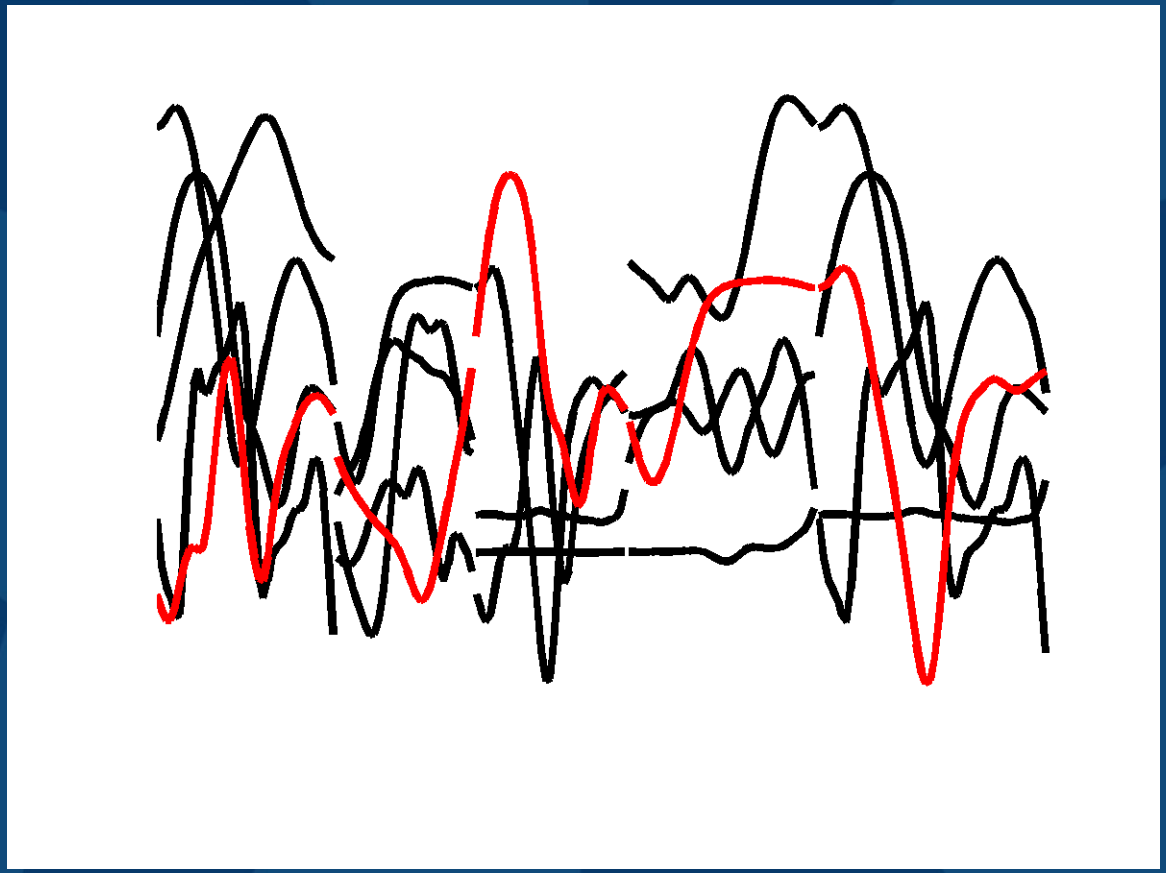
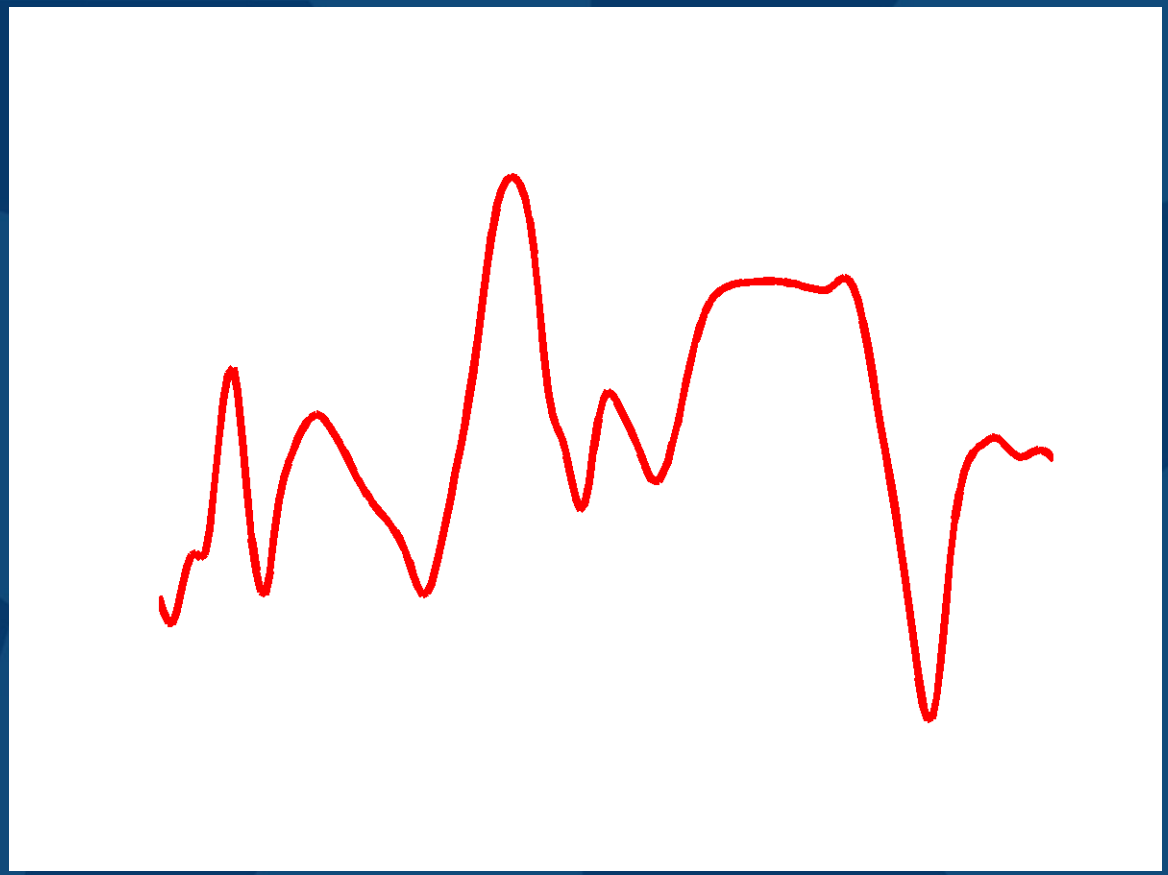
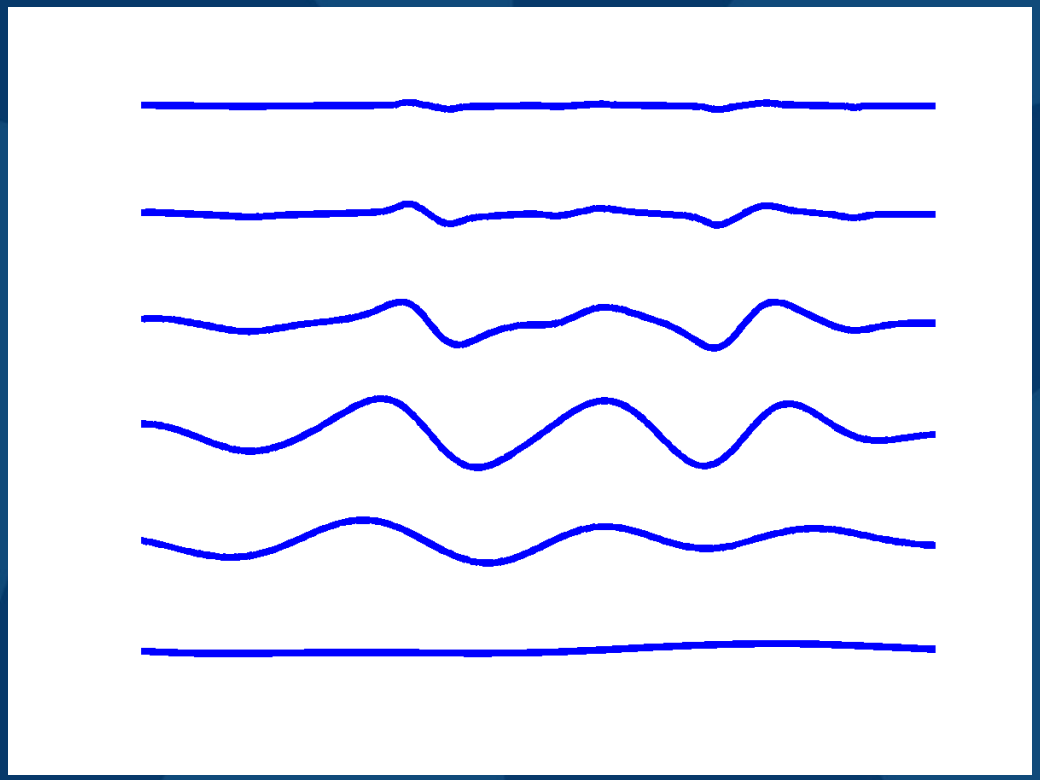


Joining



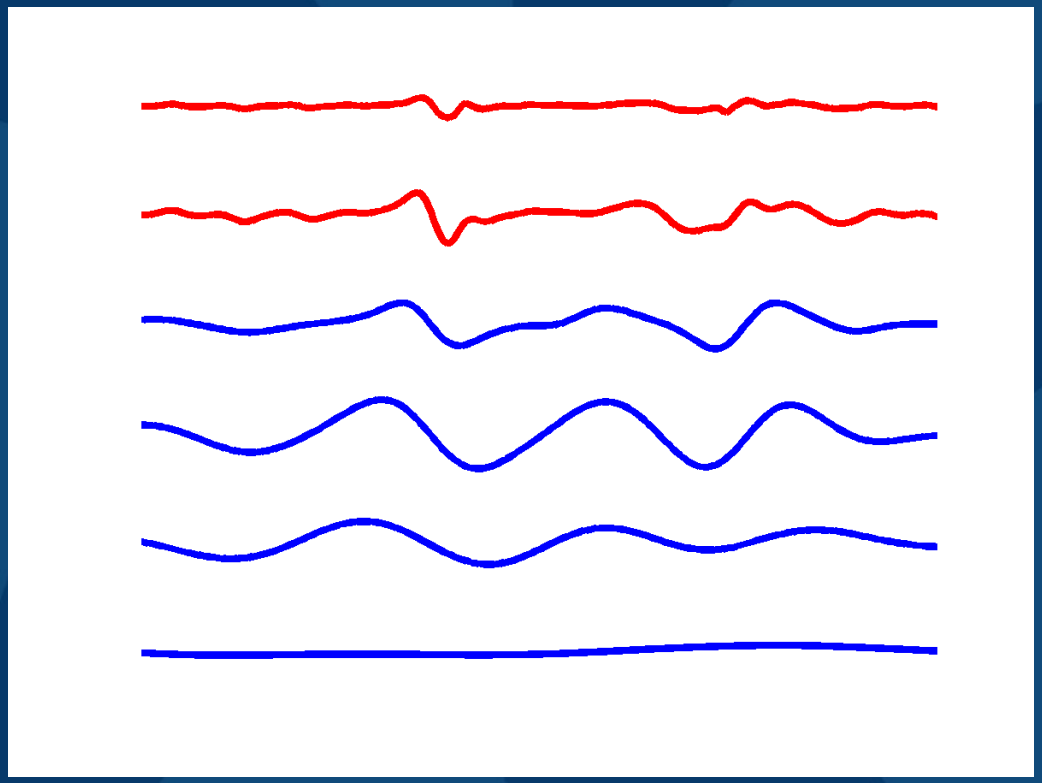
Texturing

Band-pass decomposition of keyframed data

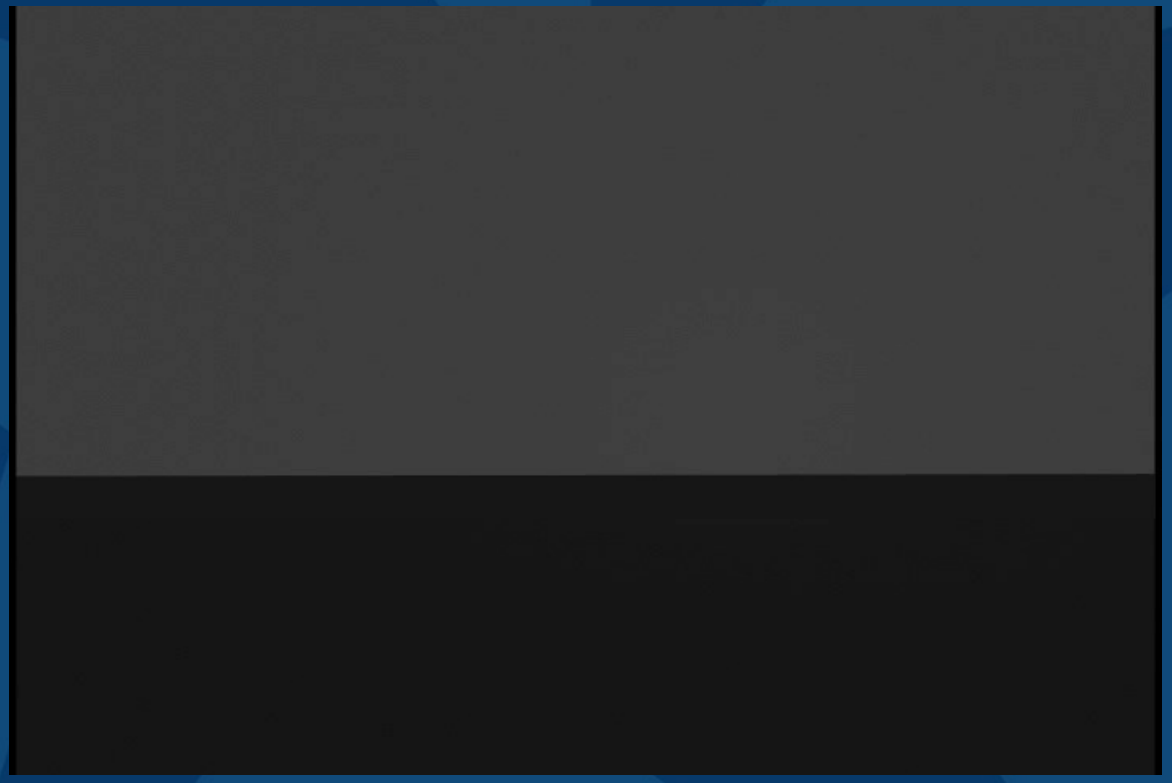


Texturing

Synthesize upper frequency bands



Keyframed Sketch



Motion Capture Data

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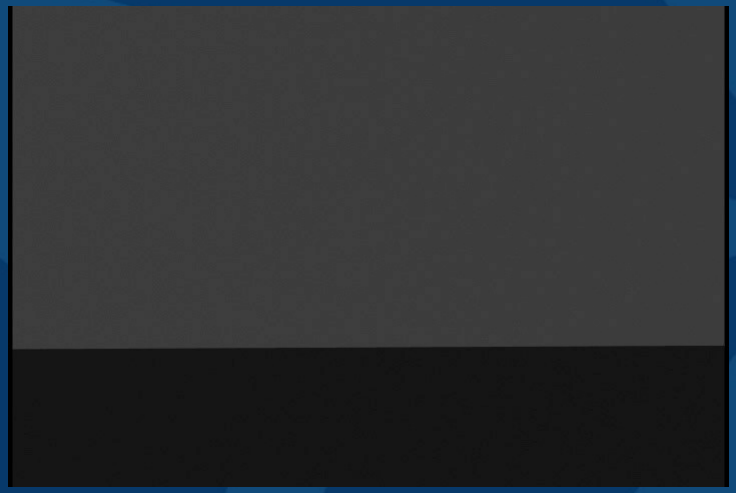
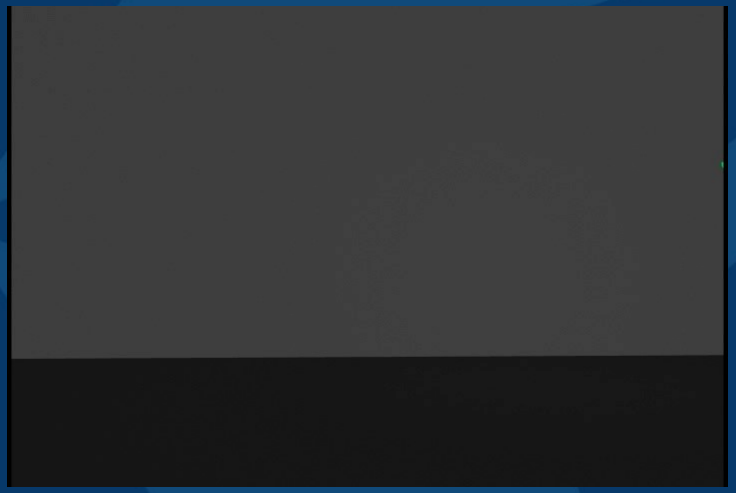
Two different styles of walk



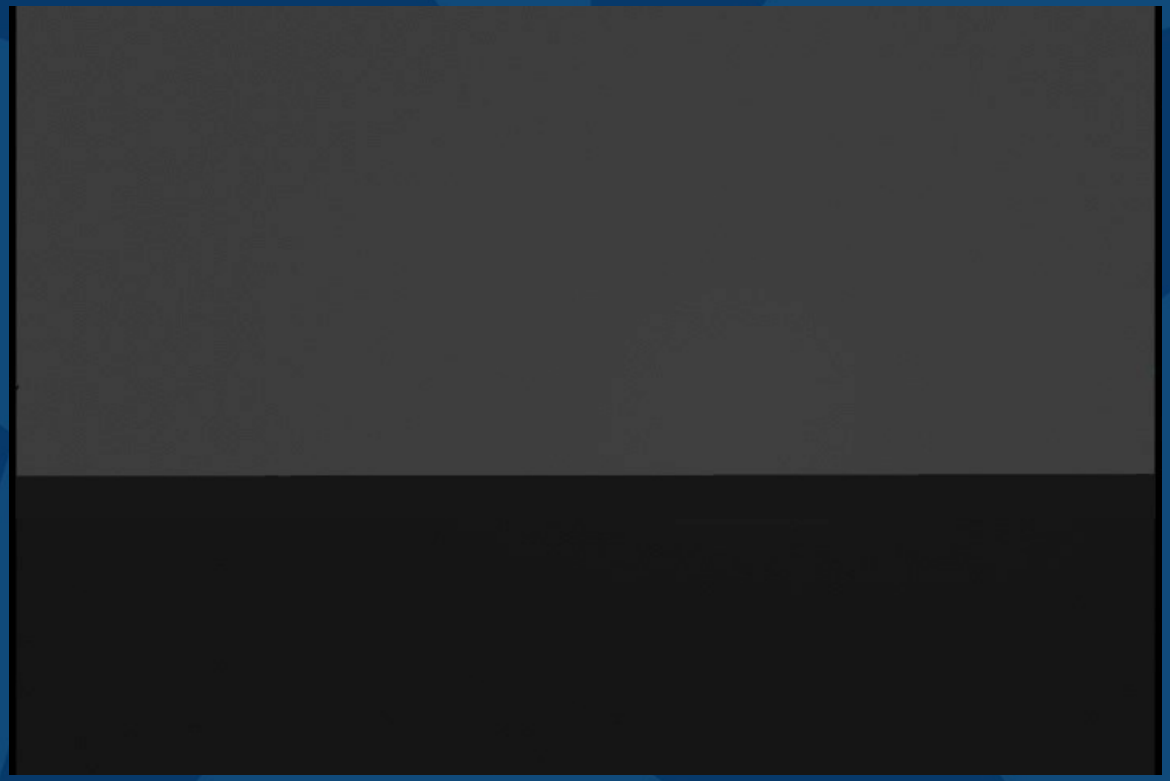


Enhanced Animation

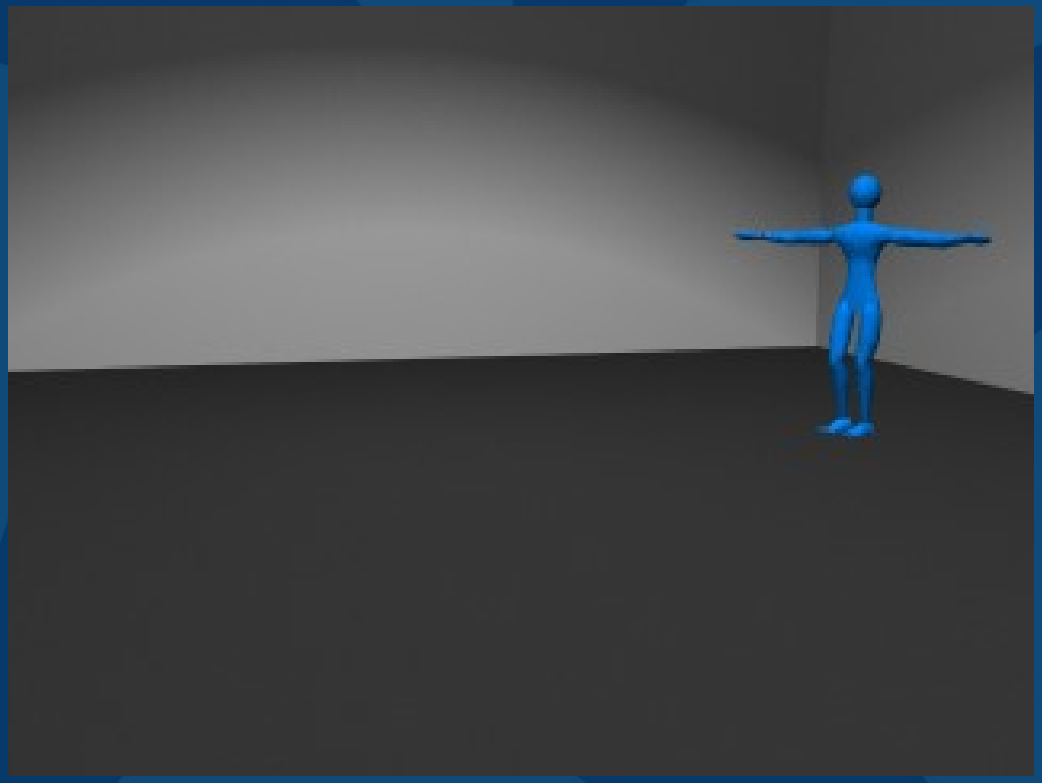
SAN ANTONIO SIGGRAPH 2002

Upper body is synthesized

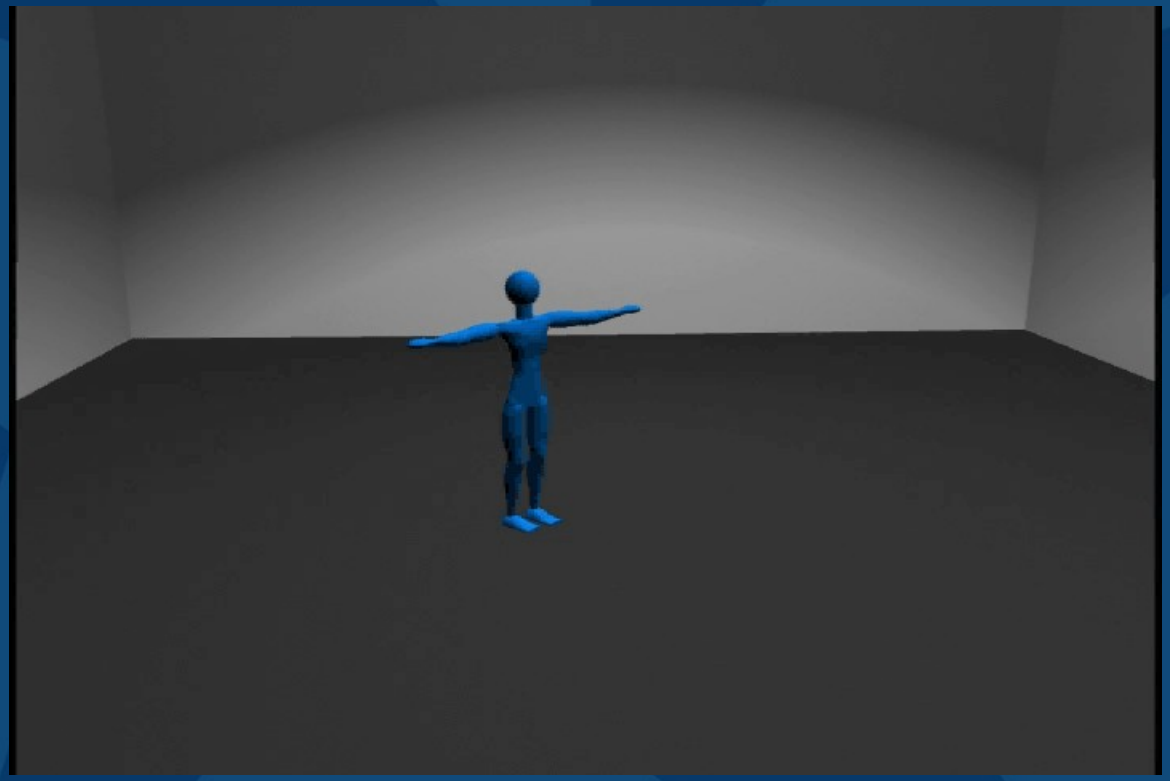
Lower body is textured



Keyframed Sketch With More Detail



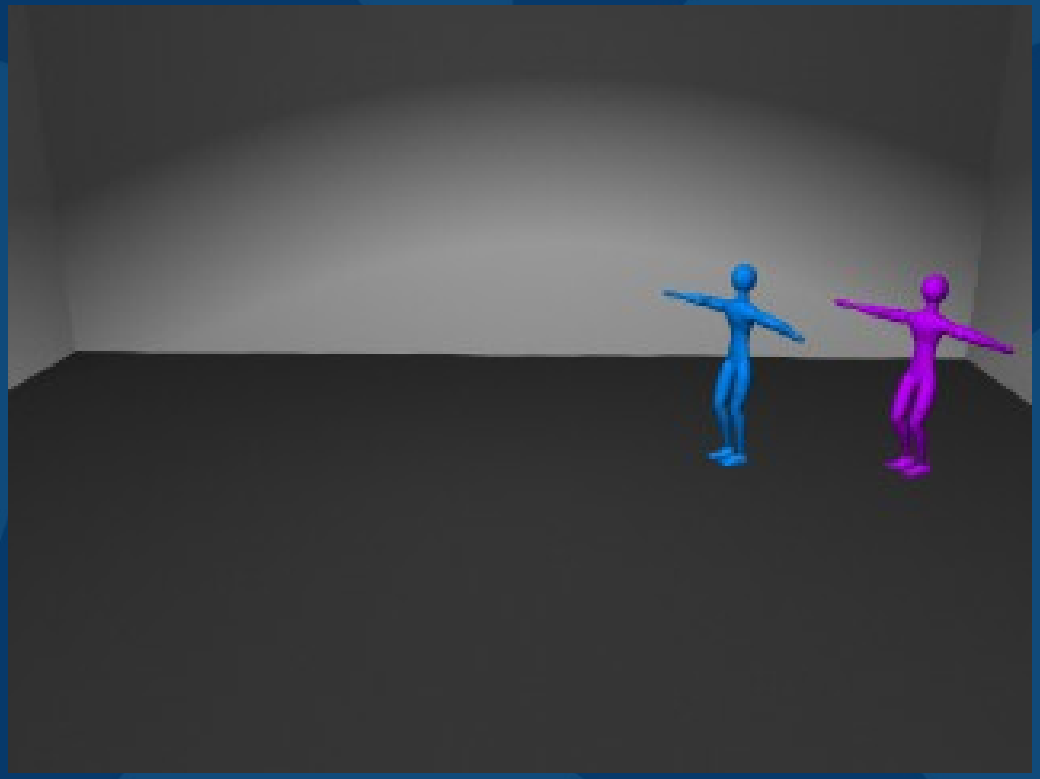
Motion Capture Data



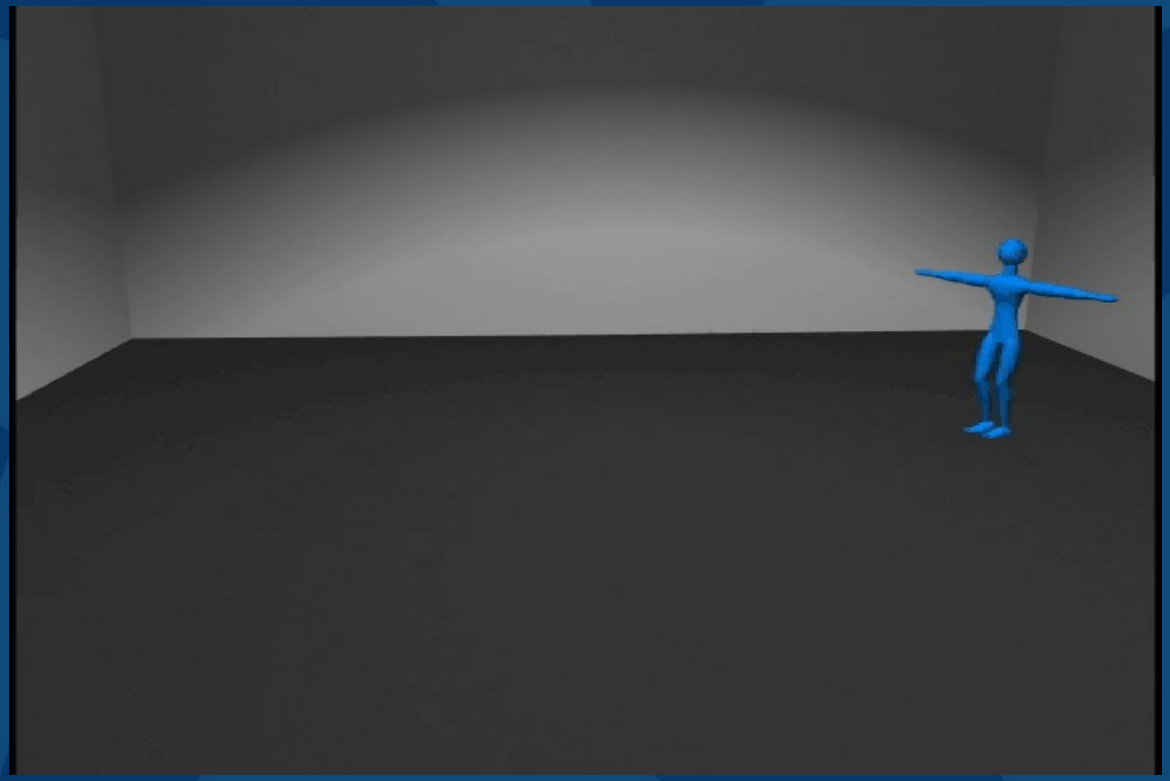
Textured Animation

Blue = Keyframed

Purple = Textured



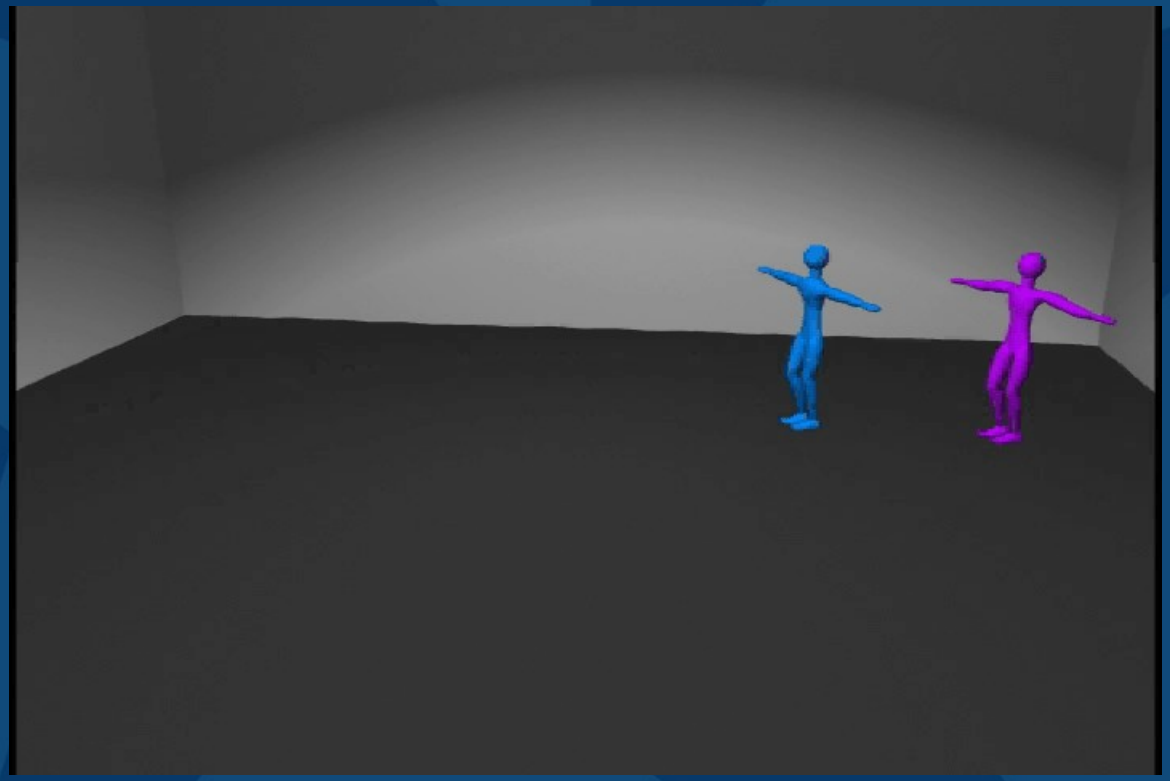
Lazy Keyframed Sketch



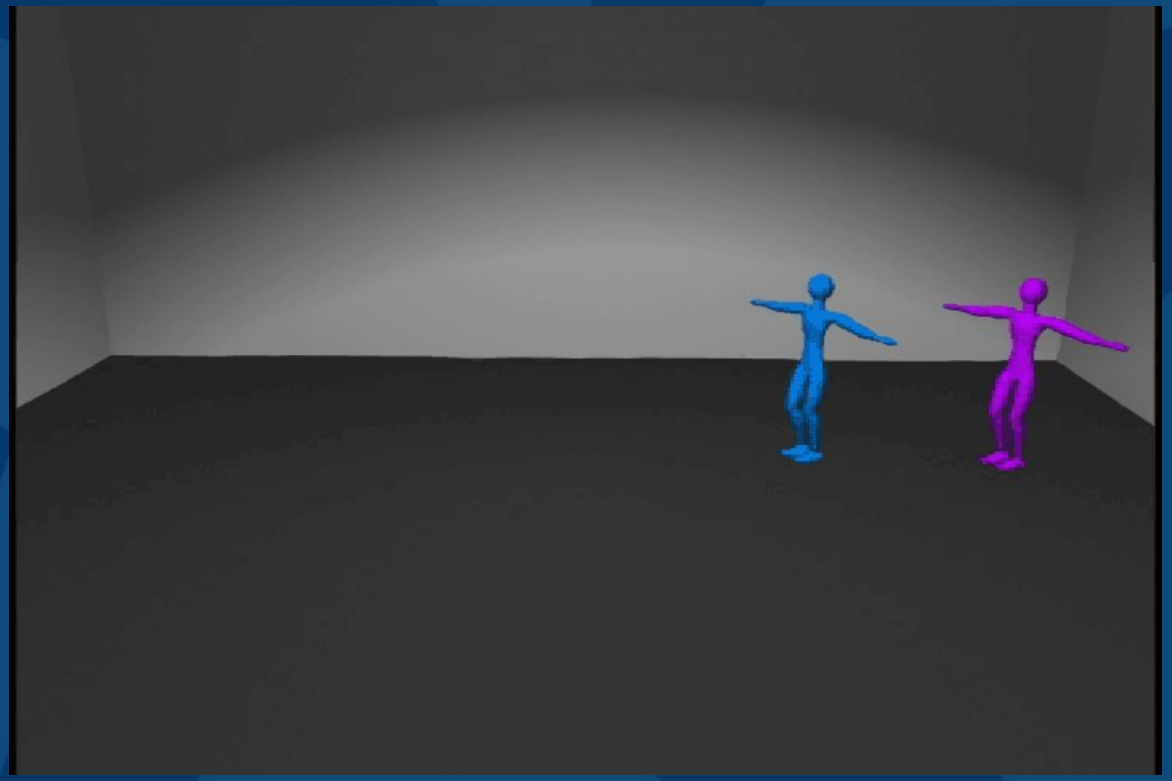
Enhanced Animation

Blue = Keyframed

Purple = Textured/Synthesized



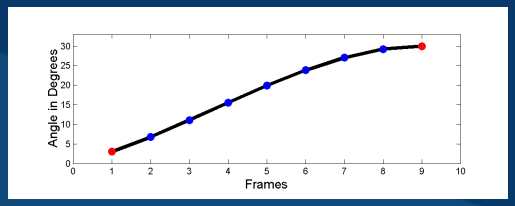
Different Paths



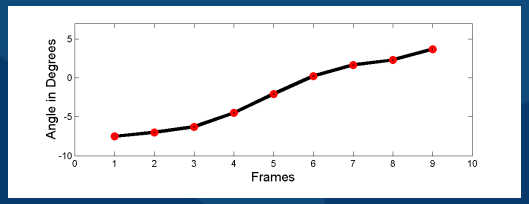
Summary of the Method

Sketch + Mocap

Keyframed data

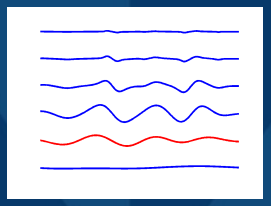


Mocap Data

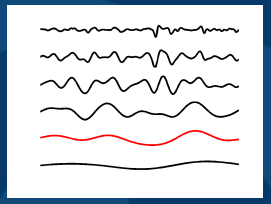


Frequency Analysis

Keyframed Data

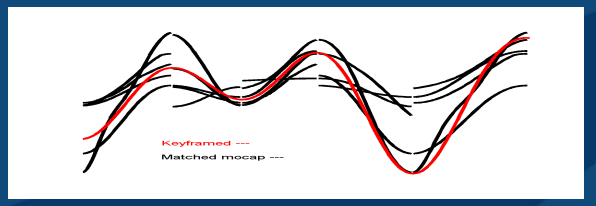


Mocap Data

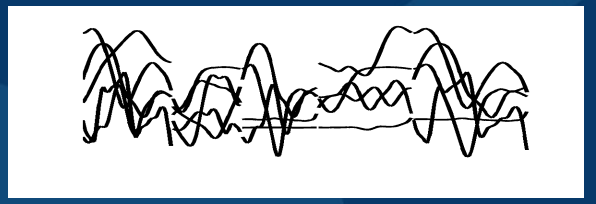


Matching

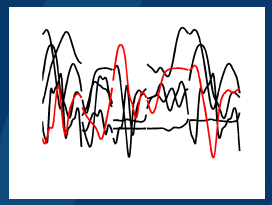
Matching Angles



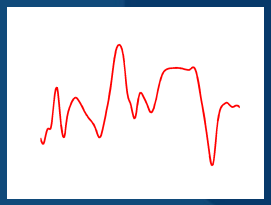
Possible Synthetic Data



Path Finding



Joining



Enhanced Animation

Conclusions and Applications

- For more automatic generation with high level control, the previous methods are more appropriate
- Appropriate for an artist interested in a very particular style of motion
- The artist may have a relatively small motion capture set of that style
- The artist may want precise control over parts of the motion

For more info. . .

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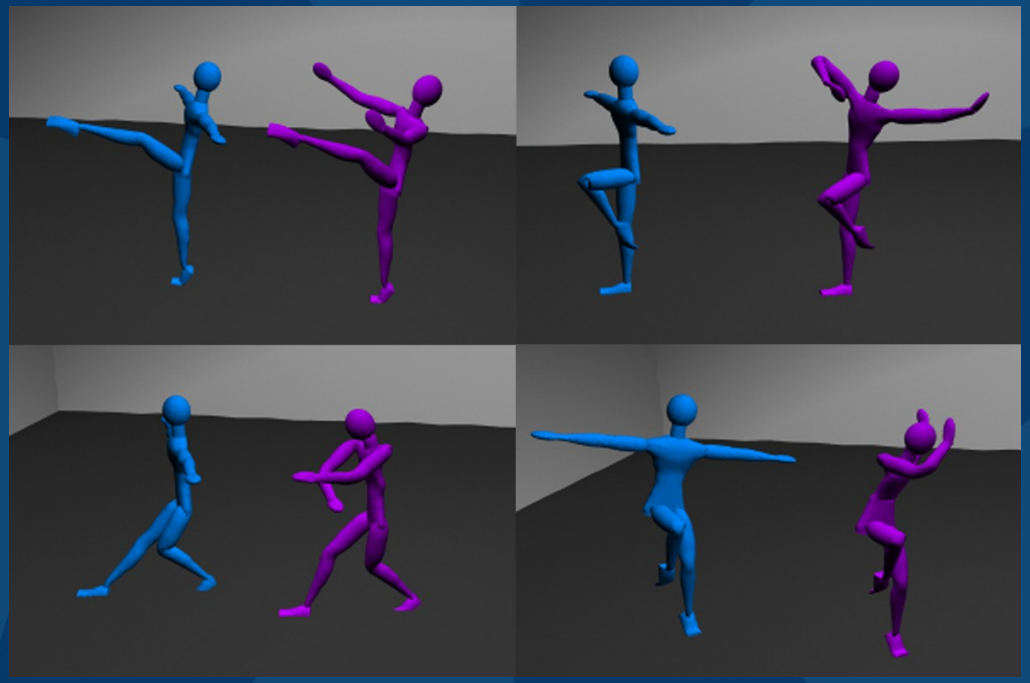
http://graphics.stanford.edu/~pullen



Special Thanks to:
Reardon Steele, Electronic Arts

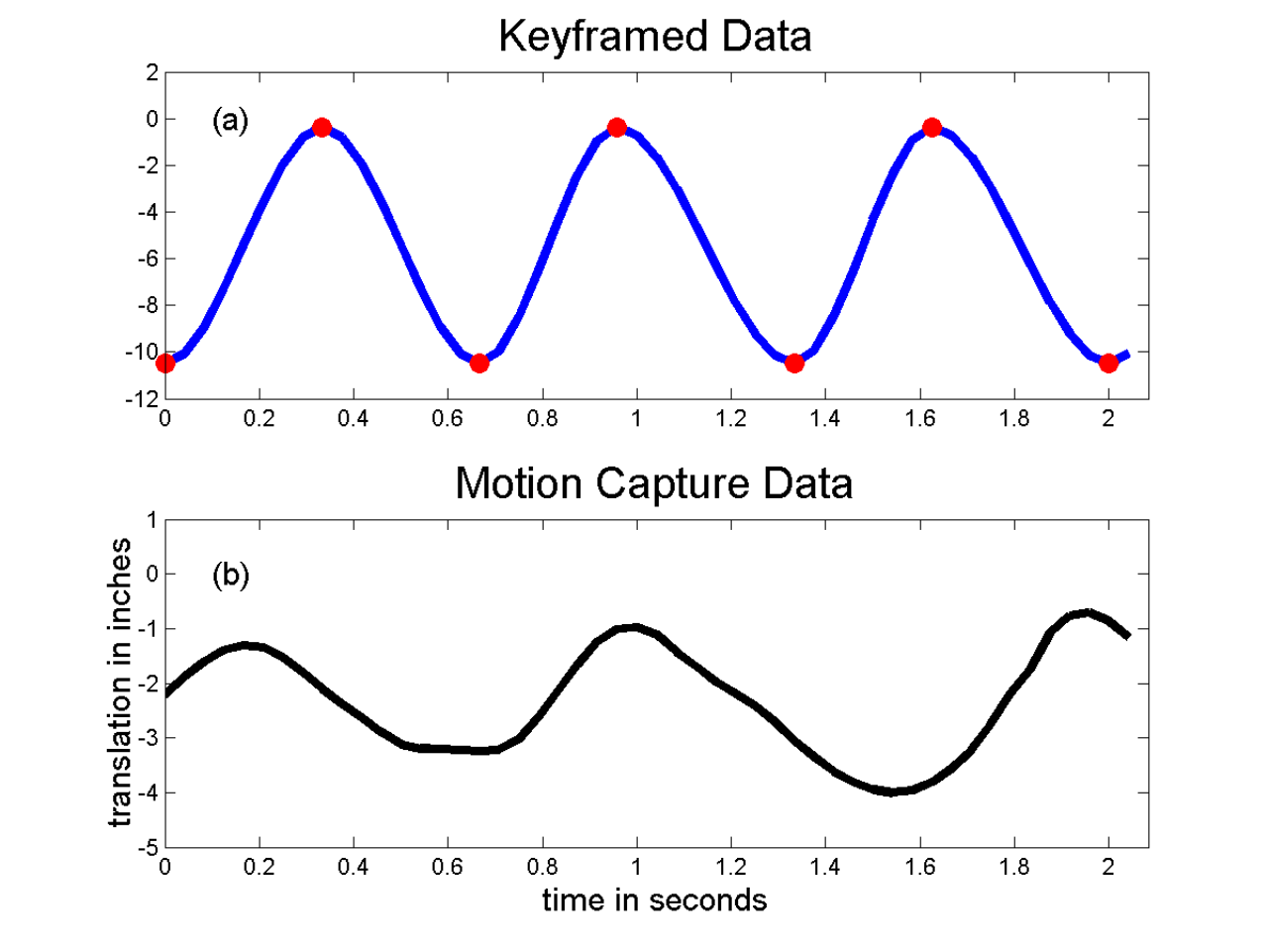
Choices the Animator Must Make

1. Which DOF to use as matching angles
2. Which DOF to texture, which to synthesize
3. Which frequency band to use in matching
4. How many frequency bands to use in texturing
5. How many matches to keep

Conclusions and Further Work

- Direct incorporation of hard constraints
- Fundamental units of motion

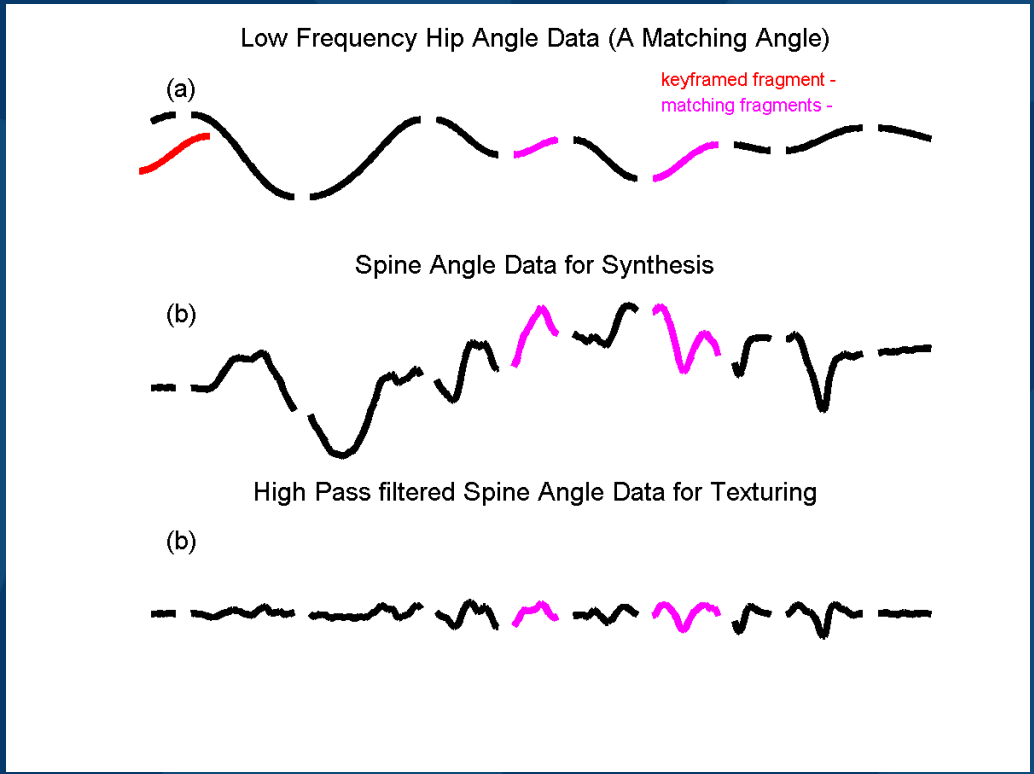
Keyframe Data vs. Motion Capture Data



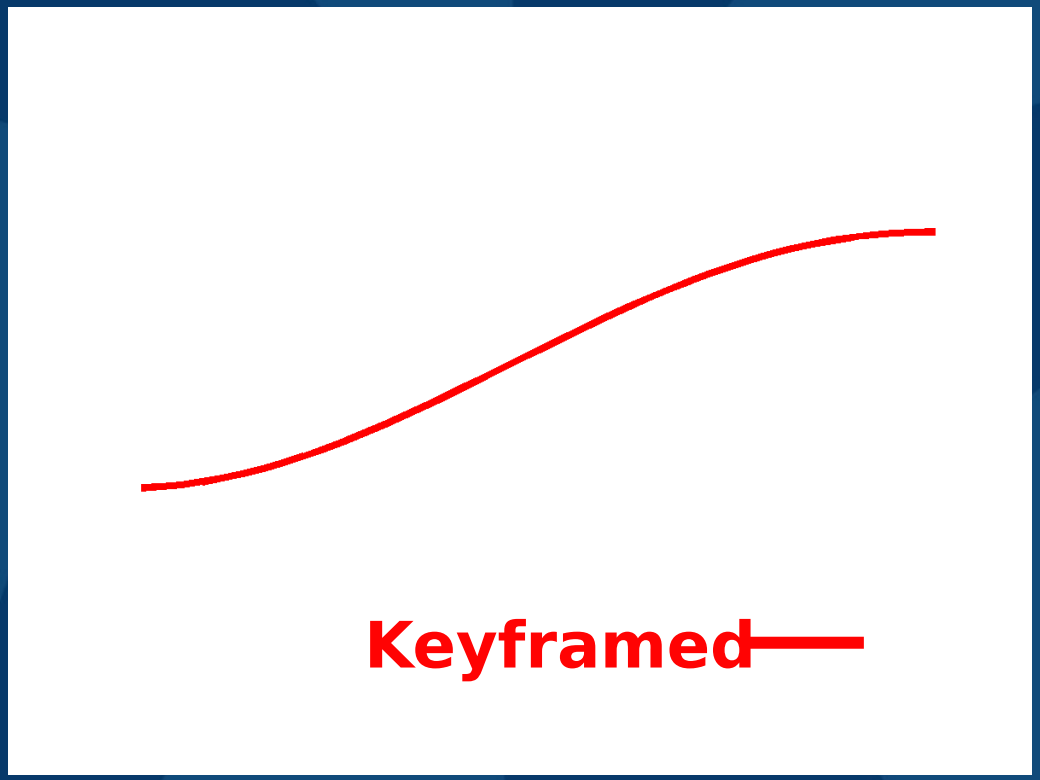
Texturing

SAN ANTONIO SIGGRAPH 2002

Synthesize upper frequency bands

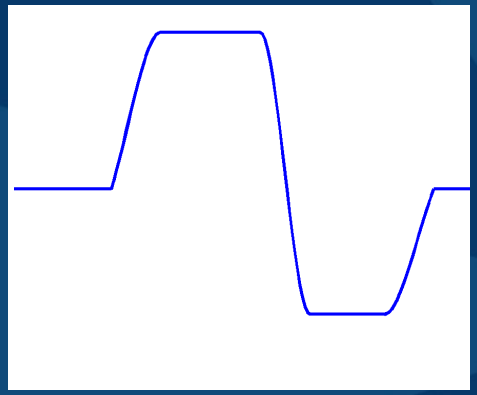


Matching



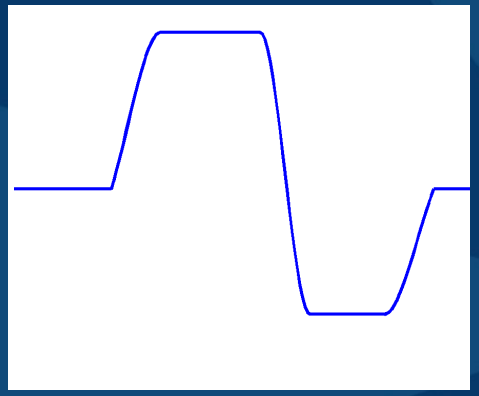
Enhancing Animations: Texturing and Synthesis

Keyframed

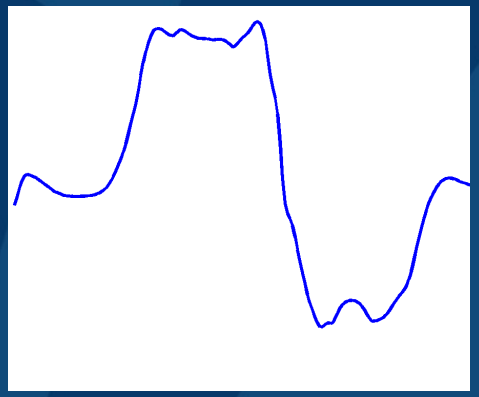


Enhancing Animations: Texturing and Synthesis

Keyframed



Textured



Enhancing Animations: Texturing and Synthesis

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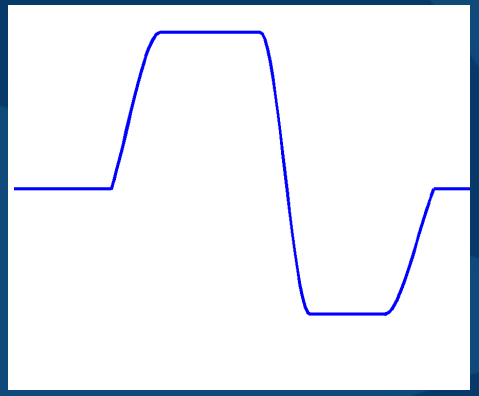

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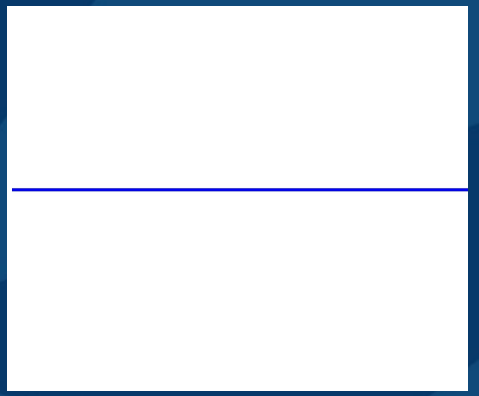
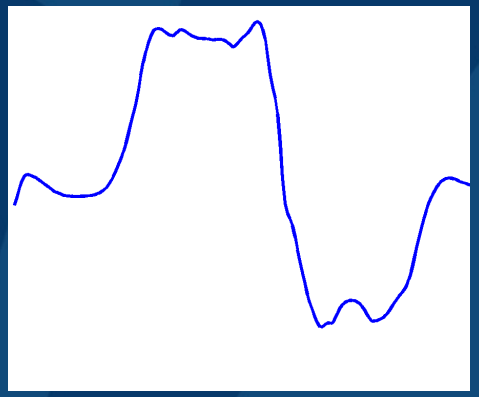
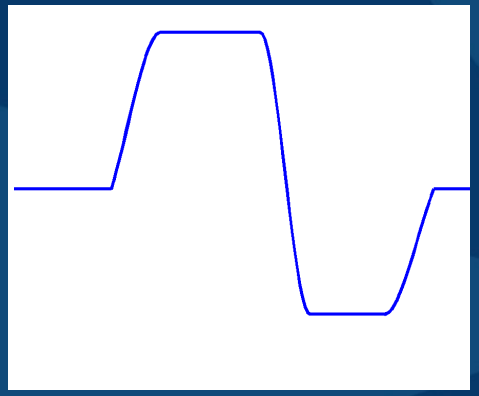


Textured



Enhancing Animations: Texturing and Synthesis

Keyframed



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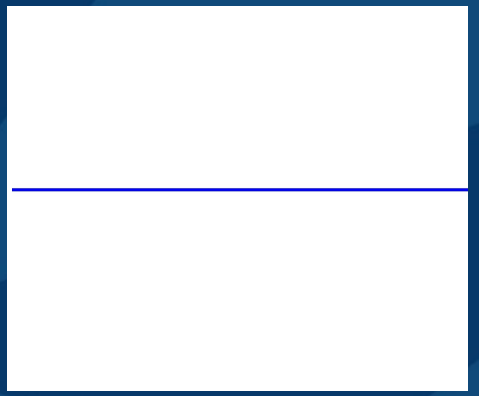
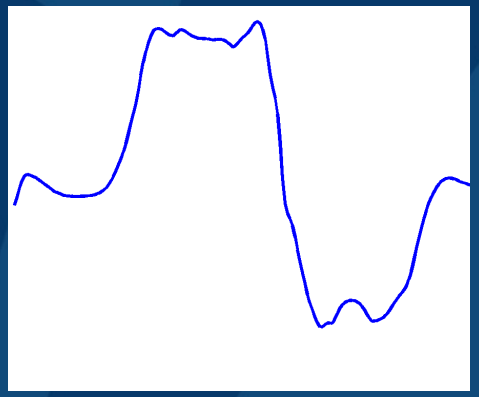
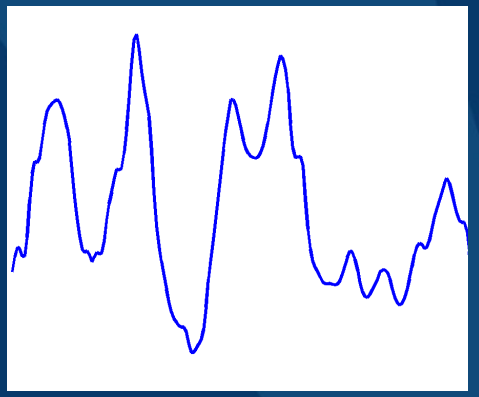


Textured



Synthesized



Keyframing vs. Mocap

	Advantages	Disadvantages
Keyframing	• Control	
Mocap		